WORK AND WAGES

Part I.

WORK AND WAGES

IN CONTINUATION OF

LORD BRASSEY'S 'WORK AND WAGES'
AND 'FOREIGN WORK AND ENGLISH WAGES'

PART I.

FOREIGN COMPETITION

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INTRODUCTION

It is my privilege to write an Introduction to a volume by Professor Chapman, dealing with British and foreign labour. The present volume may be regarded as the sequel to *Work and Wages*, published in 1872, and to my later book, *Foreign Work and English Wages*, published in 1879. Professor Chapman has brought the inquiry up to date.

Some personal explanations may here be given. I had desired to examine anew the relative efficiency of British and foreign labour. Unaided, the task was evidently impossible. In Professor Chapman, trained in Economics at Cambridge under Professor Marshall, and now Professor of Political Economy in the University of Manchester, I have found an able fellow-worker of a younger generation—more, indeed, than a fellow-worker—the volume now published being entirely from the pen of Professor Chapman. I can perhaps the more unreservedly commend it.

The topics discussed in *Work and Wages* and *Foreign Work and English Wages* fall naturally into two classes. First, there are questions as to the comparative efficiency of labour in different countries, in the most important industries. Secondly, there

are questions as to the most suitable methods of adjusting the rate of wages; as to the influence of trades unions and friendly societies; and as to the possibilities of co-operation in its various forms. These were beyond the scope of a single volume. Different subjects would naturally attract a different circle of readers.

Summarising generally, it may be said that the present volume deals directly with the industrial efficiencies of the leading countries. The second volume, under the title of 'Labour and Capital,' will deal with the labour problem under other aspects. Professor Chapman has been careful to steer clear of the fiscal controversy.

Few writers on economics can claim export knowledge of any industry. Their part is to collate and compare collective results. In a wide field of inquiry errors here and there are unavoidable. In essential facts we should not go astray. As in the earlier works already named, so now, the task has been mainly that of selection and compilation. It has been attempted to weigh and sift evidence, to separate the important from the unimportant, and to find explanations of the more striking features of industrial development. A special value attaches to the judgments of British experts on foreign and to the judgments of foreign experts on British industries.

The first chapter of the present volume deals with foreign competition generally. In the second chapter the coal trade is reviewed. We have no reason as yet to fear competition, whether from the

New or the Old World. For steaming purposes our Welsh coal is unsurpassed in quality; we may regret that the supply is not inexhaustible. English mining engineers are exceptionally skilful in dealing with shaft mines. The English collier still remains superior in efficiency. He is better paid and fully earns a liberal wage. In the United States the use of machinery is more general than with us. In every industry the Americans are not less conspicuous for their public-spirited readiness to give information even to competitors than for their inventive skill.

Germany has great natural resources, and the output of her coal mines shows a rapid expansion.

Chapter III. deals with the iron and steel industries. In proportion to the natural resources at command, Great Britain fully holds her own. In quantity of production we cannot keep pace with the United States. While the output of ore from the mines in our own country is limited, we are advantageously placed for the importation of Spanish and Swedish ores. The cost of assembling the material for a ton of pig at Pittsburg has been reduced from 1*l.* 15*s.* 3*d.* to 1*l.* 3*s.* 9½*d.* At Middlesbrough it has been brought down to 16*s.* 5*d.* a ton.

As it has been shown by Sir Lowthian Bell, in able reports extending over many years, and embracing the state of the iron industry both in Germany and the United States, the costs of our Cleveland smelters are less than in any part of Germany. Sir Lowthian Bell found no smelting works in the Old World or the New to compare with those at Middles-

brough. He attributed our superior labour efficiency to our more liberal rates of wages.

Descending to a later date, in 1896 a British delegation, after a tour through Belgium and Germany, reported that the United Kingdom was at least as advanced as Germany. The delegation, while commending highly the physique of the German workmen and the value of their military training, were nevertheless confident that any difficulty we might have to encounter in competing with Germany would not be due to the greater cost of British labour; if more highly paid, our labour was efficient in proportion. The delegation were impressed with the perfect organisation of many works they visited in Germany. Care was bestowed on the smallest details. Germany had some advantage in having come late into the field. The metallurgical industries were up to date. The Bessemer and basic processes, and all the latest inventions, had been skilfully worked. In efficiency of labour Germany had no advantage. The production per man was less than in our British industries. If the German masters were in advance in technical attainments, their British competitors had more practical knowledge of the management of labour—knowledge often gained in early life while working in the ranks.

The advance of the United States to the supremacy they now hold as producers is due to the natural resources of that vast country and to a high level of efficiency. The chief improvements introduced in the United States are fully described in the

chapter under notice. If wages are more liberal than with us, house rent is dearer. The cost of living is about the same. The rough work around blast furnaces is not attractive to the American. The workers are mostly foreigners, inferior in efficiency to the skilled men in British establishments.

The iron industry is extending in Russia, where large works have been established, but chiefly under foreign management. The demand for manufactured iron is, however, comparatively limited, and comes chiefly from the Government. The Russian worker is patient and obedient, receiving comparatively low wages as the reward of long hours of toil.

Chapter IV. Shipbuilding.—In tonnage the mercantile marine of the British Empire more than equals the combined merchant fleets of the world. We possess unrivalled advantages, not the least being the national instinct and aptitude for the sea. As shipbuilders we claim no superiority over the best work of our German competitors, whose ocean greyhounds thus far hold the record. Other countries may equal us in the quality of their work; none can compete in the cost of building those tramp cargo steamers, in which the great bulk of the world's trade is carried. We owe our success to the cheap supply of raw materials and to the large quantity of tonnage of the same class turned out. Our builders are thus enabled to standardise types. Three or four tramp steamers, from the same design, may sometimes be seen in progress in our builders' yards side by side. As Messrs. Schwartz and Hallé have shown in their

recently published work, 'Die Schiffbau-Industrie,' our shipbuilding industry stands easily first in the supply of labour. Our workmen are second to none.

Special efforts have been made to extend shipbuilding in the United States. The more recently formed establishments are laid out after the most approved plans and fitted with the most recent machinery. Thus far the construction of steamships has been comparatively limited, while the cost, according to the estimate of Mr. Cramp, is 15 to 25 per cent. greater than with us. This difference would disappear if the demand for tramp steamers were extended. The vast coasting trade of the United States is still carried on mainly in sailing vessels. The disappearance of sailing vessels from the British mercantile marine is of doubtful advantage. They were the nursery for a hardy breed of men whom we can ill afford to lose.

In France naval architecture is carried to the highest perfection as to quality. Economical production is not promoted by lavish bounties to shipbuilders and shipowners. It has become a habit with those concerned to lean on artificial props. The hindrances of a severe protective system justify demands on the Government, which in a free-trade country would not be entertained.

The chapter under notice includes mechanical industries. The manufacture of locomotives is not developed in England on the scale which has been reached in the United States. Our leading railways have manufactured for themselves. It has not been

possible to standardise in England, as in the United States, where the Baldwin Works, building from standard patterns, are able to execute large orders more promptly than is possible in English establishments which are often full of work.

As the result of the trials carefully and impartially made on the Egyptian railways, under the direction of Lord Cromer, it was shown that in efficiency the English makers can hold their own. The consumption of coal was decidedly heavier in the case of American engines. Belgian engines have been tried in Egypt. Their coal consumption is not excessive. The materials, both of boilers and of engines, are inferior; the cost of repairs is in consequence heavier. Steaming capacity and adhesive power are distinctive merits of American and French engines. The British system of light loads and frequent services has not called for machines of the same ponderous type. As in locomotives, so in bridge-building, the American manufacturers, building to standard patterns, surpass the British in quickness of delivery.

Turning to other descriptions, English makers retain the leadership in cotton and linen machinery. The name-plates of honoured firms, such as that of Platt of Oldham, are seen in every centre of the cotton industry. As the textile industries of Great Britain have created a demand for spinning and weaving machinery, so the vast agricultural operations of the United States have stimulated the production of agricultural implements and encouraged invention.

British machine-tool makers hold their own, even in competition with the United States, in the manufacture of heavy tools. The American makers excel in the manufacture of the lighter machines and more highly specialised instruments.

The Germans are pre-eminent in working scientifically. They have a genius for special machinery of an unusual type. They do not rival the makers of the United States in turning out rapidly and cheaply repeats of the same machine. American makers gain an advantage over their British rivals in not aiming at the production of machines as durable as ours. They obtain some orders through their readiness to guarantee performance. They produce tools cheaply, because malleable and steel castings are largely used.

American engineering in general is highly efficient. In the workshops all materials are transported mechanically. Highly skilled labour is economised in every possible way. The American is a good buyer and seller, and a splendid works manager. In America, more generally than with us, workmen are taken into the masters' confidence and encouraged to assist in bringing designs to perfection.

In electrical engineering the United States have taken the lead. As a new industry, with a wide field for expansion, it is specially attractive to an enterprising people.

Chapter V. Cotton Industry.—The cotton industry of Great Britain has been long in a commanding position. In Continental Europe, and in the United

States, the rate of progress has been more rapid than with us. We are still leading. No fewer than 500,000 operatives are employed in the British cotton industry —three and a half times as many as in Germany.

For any comparisons of British labour efficiency with that of our rivals in Continental Europe, Professor Schulze-Gaevernitz is the leading authority. In energy, skill, and watchfulness, English workers are unsurpassed. In England the number of workers employed to tend machinery is sensibly less than in Germany, and less supervision is required. Hence the cost of labour per pound of yarn spun is decidedly less in England than in Germany. We have approximately two looms to each operative. In Saxony the number of the looms and the number of operatives are about equal. Hence, though wages in Lancashire are considerably higher, the cost of spinning is less. In England the cotton industry is more specialised. Factory operatives in Germany are not, to the same extent as in England, a class trained from childhood. In Germany manufacturers are more ready to accept small orders for new designs.

In England we have an advantage over the Continent in the humidity of our climate. In an atmosphere less saturated with moisture it would hardly be possible to produce our goods of the finer counts. Our exports of cotton goods show some fall in quantity. The values are fully maintained, our exports consisting chiefly of the finest qualities.

The cotton industry of France is of long standing, and is mounted on a considerable scale. The success

of the industry is due to the beauty and inexhaustible originality of French design.

In extent of production the cotton industry of the United States stands second only to that of England. American operatives are a migratory body, recruited from every nationality.

Bombay is becoming a powerful rival to Lancashire. Indian cotton is not suitable for fine spinning; though the range of Indian work is extending. In a volume chiefly devoted to the relative efficiency of labour it is of special interest to note that though the mills in India are run 350 days in the year, and for 11½ hours a day, with swarms of hands in comparison with the numbers needed in English mills and with weekly wages incomparably less, the labour cost is far higher than in Lancashire, where the hours of labour are 55½ per week, and 306 days only are worked in the year. The Indian operatives have less physical endurance and less power of continuous application. It is said that they are becoming more efficient.

Chapter VI. Woollen, Linen, Silk, and Hosiery.—The chapter opens with the statistics of the production and consumption of wool. In the United Kingdom we have nearly three times as many sheep as in Germany. In woollen goods England has not the same pre-eminence as in the case of cotton manufacture. The woollen industry in certain branches does not need the highest technical skill, nor does it need the special atmospheric conditions found under our gloomy skies. The German manufacturers pro-

duce chiefly the heavier descriptions. English goods are of comparatively fine quality and command higher prices. German cloths are inferior in softness, in elasticity, and in finish.

As to wages and the cost of living, the position of the workers in the woollen industries of the United States is less favourable than is commonly supposed. The American worker, it is estimated, can save 11·6 per cent., the British worker 8·4 per cent of his income.

In the linen industry, centralised in Belfast, production is maintained, but with little prospect of expansion. Improvements in cotton fabrics are constantly bringing about their substitution for linen. In ability the manufacturers of Ireland are unsurpassed. Dr. Heinz Potthoff-Bielefeld, an authority on the linen industry, ascribes our success to the specialisation, which enables each factory to confine itself to a few descriptions and to bring them to the highest perfection at the lowest cost.

Russia is the chief flax-growing country, producing two-thirds of the world's yield Under the protection of prohibitory tariffs the Russian flax industry has slowly advanced in thirty years from 83,000 to over 300,000 spindles, as against 1,600,000 spindles in Great Britain, 550,000 in France, and 360,000 in Germany.

In silk we have never attained to the perfection we have reached in other textiles. The Cobden Treaty opened our markets to French competition. Our exports of silk have remained stationary since the

treaty, while the imports have advanced from 2,000,000*l.* sterling to 16,000,000*l.* sterling. The pre-eminence of the French manufactures of silk is due to the skill, taste, and personal application of the manufacturers. The dyeing, weaving, designing, selection of colours, and finish demand the utmost care. In Lyons it is said that everyone concerned 'puts a certain amount of feeling into his work.'

Chapter VII. Chemicals and Dyes.—This chapter deals with an industry in which we have allowed our German competitors to pass ahead. They have succeeded through the care and liberality bestowed by their Government on technical instruction. We do not give sufficient attention to the training of specialists, of whom no fewer than 7,250 are employed in the German industries.

In the chemical trade as a whole we do not occupy the same commanding position as in the metallurgical, textile, and mining industries. Our exports of cotton goods may be taken at 62,000,000*l.* sterling; our exports of iron and steel goods and machinery at 40,000,000*l.* These figures throw our chemical industries into the shade. The chemical industries have not received a due share of attention from our capitalists. Adopting the same classification as in Germany, our exports are 13,554,000*l.* sterling, as against Germany's 18,150,000*l.* sterling.

French exports of chemicals are only about half those of England. The exports of the United States are little more than half those of France.

In painters' colours—an important branch of the

colour industries—we are making rapid progress. Exports, 1880-84, 1,256,000*l.*; 1897-1901, 1,836,000*l.*; 1902, 1,968,000*l.*

The Chapter on Railways gives the leading statistics for all countries. An ample field is still open to enterprise, even within the limits of the British Empire. The cost of construction throws little light on labour efficiency. The differences are wide—in the cost of land, law expenses, the character of the permanent-way, station accommodation, and in the physical features of the countries traversed. In engineering we are not behind the highest standards of foreign countries. In the Report to the Board of Trade by Colonel Yorke, in 1903, American and English practice are compared in detail, and not to our disadvantage.

It is difficult to compare rates. In the United States, over distances far exceeding those with which we have to deal, rates may be lower than with us, and yet sufficiently remunerative. On branch lines, and in that local distributive service which forms so large a part of the work of British railways, the rates in America are at least up to the English standard.

Train loads are far heavier in the United States. On the Pennsylvania line, trains of a gross weight of 2,000 tons are drawn by mammoth engines, more than 100 tons in weight, over distances measured in thousands of miles. In England we are using trucks of larger size, and building four-wheeled trucks capable of carrying heavier loads. The London and North-Western Company have recently constructed

20-ton trucks, with a tare of only 8 tons, or approximately the same percentage of dead-weight as in the American 50-ton steel cars. To introduce the mammoth engines of the United States on British railways would involve reconstruction of bridges and tunnels at enormous cost. Changes must be gradual. When shown to be necessary and possible they will come. The critics of our British system should remember that it was designed for an earlier age of the world, and for simpler business than that with which we have actually to cope.

At the close of the chapter on Railways allusion is made to the labour-saving appliances for the loading and discharge of ships engaged in the transportation of iron ore on the Great Lakes. They are described by Mr. Sahlin in his Report to the British Trade Associations in 1902. He gives an illustration of what has been accomplished. He had seen a steamer arrive in port in the morning with a cargo of 6,700 tons of ore, and leave the same evening in ballast for the Upper Lakes. Carriage on the Lakes is cheap. Ore can be conveyed from the head of Lake Superior to Cleveland for 2*s.* 6*d.* a ton. The problem of transportation is of vital importance in the vast North American continent. It has stimulated the inventive faculties of a most ingenious and enterprising people. It is satisfactory to know that Great Britain, the pioneer in the construction of railways, has maintained an ever-advancing standard of efficiency. In no country, where the conditions can in any sense be compared with our own, are

superior facilities afforded for the service of trade and the convenience of travellers.

In conclusion, in penning the Introduction to the present work by Professor Chapman, it has been a pleasing duty once again to speak highly of the merits of our British workers. We have passed in review all our leading industries, and have found that British workmen are second to none. If we have been excluded from foreign markets, it has been due, not to the inefficiency of our workers, but to tariffs imposed through dread of British competition. Their protectionist policy is a tribute paid by foreign competitors to the sterling merits of our workers and to the able direction and administration of our industries. And yet we have always the incapable, the thriftless, and the self-indulgent. It is the part of statesmen and captains of industry to raise to a higher plane those who are now a burden to the nation. We may expand the work of commercial education, for which Sir Albert Rollit, backed by the London Chamber of Commerce, has done so much in the metropolis. We may improve our methods of work, and give greater encouragement to skilful labour by participation in profits.

The ample and interesting collection of statistics and expert opinions which Professor Chapman has brought together confirms the conclusions reached in my earlier volumes. The cost of labour varies less than might be supposed. There is compensation for the payment of higher wages, as well in the stimulus they give to invention and to care and thought in

improving methods of work, as in the superior physical powers and in the spirit and energy of well-paid workers.

Once again I desire to tender my acknowledgments to Professor Chapman. The volume which he is now publishing may, I trust, be useful, especially at the present time. Without his aid it could not have been produced. Our obligations for professional advice are very numerous. It is impossible to exhaust the list of names. We desire especially to thank Mr. Macfarlane for his careful work in the revision of proofs.

TABLE OF MONEY AND WEIGHTS USED IN THIS WORK, WITH THEIR ENGLISH EQUIVALENTS

Money

20 marks = 1*l.* = 25 francs.
Dollar = 4*s.* 2*d.*
1 pfennig = $\frac{1}{100}$ of a mark.
1 cent = $\frac{1}{100}$ of dollar.

Weights

Kilogramme = 2·204 lbs. Avoirdupois.
Metric ton = 1,000 kilogrammes = 2,204 lbs.
(American) short ton = 2,000 lbs.
Long ton = English ton = 2,240 lbs.

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CHAPTER I

THE CONDITIONS OF INTERNATIONAL TRADE

Many of the opinions that are commonly held as to the relation of international trade to a country's prosperity and also as to the causes of foreign competition suffer from vagueness or positive inaccuracy. Thus it is sometimes believed that a country's welfare may be measured by the amount of its external trade; or, again, that a country is beaten absolutely by its foreign rivals in respect of efficiency in the production of such goods as it buys from abroad. Both these views are incorrect. Hence, at the outset of this essay, to avoid the misapprehensions which might otherwise arise, it will be necessary to examine in some detail the determinants of foreign trade and its relation to a nation's well-being.

The erroneous ideas that are widely current are largely due to the application of misleading military metaphors to foreign trade. Dr. Cannan dwelt specially on this source of error in his presidential address to Section F of the British Association for the Advancement of Science in 1902.[1] We speak of

[1] Printed in the *Economic Journal.* We are greatly obliged to Dr. Cannan for having read this chapter in proof.

conquering markets—meaning that we sell in them—in forgetfulness apparently of the obvious fact that such a victory must involve, at some time and in some place, ourselves being conquered in turn in the same sense. In war a nation might only win, but in trade a country cannot only sell. Undoubtedly this unsuitable military simile is accountable for part of the bad feeling and some of the exasperating acts which have impeded the course of international exchange. We actually find ourselves in danger of drifting back into the false notions of Mercantilist days, when it was supposed that one party to a bargain must inevitably lose. 'In regard to international relations,' Dr. Cannan has stated in the address to which reference has already been made, 'the first business of the teacher of economic theory is to tear to pieces and trample upon the misleading military metaphors which have been applied by sciolists to the peaceful exchange of commodities. We hear much, for example, in these days of "England's commercial supremacy," and of other nations "challenging" it, and how it is our duty to "repel the attack," and so on. The economist asks what is "commercial supremacy"? and there is no answer. No one knows what it means, least of all those who talk most about it. Is it selling goods dear? Is it selling them cheap? Is it selling a large quantity of goods in proportion to the area of the country? or in proportion to its population? or absolutely, without any reference to its area or population? It seems to be a wonderful muddle of all these various and often contradictory ideas rolled into one. Yet what a pile of international jealousy

and ill-feeling rests on that and equally meaningless phrases!'

In this essay we shall attempt to give a clear general idea of what constitutes supremacy in any branch of economic activity, and to measure our strength or efficiency—which ultimately means our serviceableness to foreigners as well as ourselves—against that of other workers in lands beyond the seas.

In the first place let us ask the question, In what relation does a country's foreign trade stand to its well-being? Does a nation's prosperity vary directly, or at all exactly, with the amount of exchange taking place over its borders? If England engaged in twice as much foreign trade as some other nation, would it be correct to say that she was twice as prosperous? Would she necessarily be any more prosperous? Or, again, if in one period England's imports and exports per head, measured in quantities, increased 5 per cent., and in another period of the same duration 10 per cent., might we infer that the rate of economic development had been greater in the second period than in the first? The answer to this last question is in the negative; and the answer to all the previous questions may be given in the general statement that, inasmuch as foreign exchange is determined by other factors as well as by productiveness, international trade and prosperity cannot be taken as indubitable indications the one of the other. Exchange is regulated by differences in comparative costs of production, and the amount of these, so to speak, has no necessary connection with efficiency, though it goes without saying that the larger the output per head, the

greater the variety of goods produced; and the higher the degree of specialisation, the greater will these differences tend to become. Thus, let us imagine two nations engaging in no trade except that with each other; and let us suppose, further, that it is possible to measure efficiency in production by the quantities of some mythical labour-capital power required for certain outputs: then we might be confronted with the following state of affairs:—

COUNTRY A

produces $1x$ with 10 labour-capital units.
,, $2y$,, 10 ,, ,, ,,

COUNTRY B

produces $1x$ with 10 labour-capital units.
,, $2y$,, 10 ,, ,, ,,

In this case both countries are in exactly the same position, and obviously exchange between them is impossible, assuming constant returns in production for the sake of simplicity, and ignoring for the same reason cost of transport within each country and between the two countries. The question of cost of transport will be neglected throughout the argument which follows.

Now observe, firstly, that prices are not ultimate determinants of enduring trade. For suppose that prices are twice as high in A as in B; then

if x costs 10*s*. 0*d*. in A
y will cost 5*s*. 0*d*. in A
x ,, ,, 5*s*. 0*d*. in B
and y ,, ,, 2*s*. 6*d*. in B

Therefore it will pay B to export both x and y, *cæteris paribus*, receiving money in return, until the reduction in the quantity of money in A and its increase in B has brought about the same level of prices in the two countries, when trade will cease.

To simplify the reasoning the same metallic basis for the standard of value and free coinage are supposed to exist in both countries. Under other circumstances the argument would be essentially the same though more complicated.

Differences in comparative prices, let us emphasise again, may start trade, but they alone are powerless to keep it flowing. Trade so initiated must soon dwindle to nothing. Why, then, it will naturally be asked, are estimates so frequently made of the money costs of production in different countries? No doubt, we must admit, they are sometimes undertaken in ignorance, those responsible for them erroneously imagining that in the money cost of production is to be found (*a*) a measure of efficiency in production, and (*b*) an indication of which countries will be able to undersell others in the future in the event of productiveness remaining constant. In other cases, however, the survey taken is so wide that an idea of the comparative state of affairs may be arrived at, especially if a notion can be formed of the level of prices in the various countries. It is of little value to know merely the average cost of production of pig iron in Pittsburg and Cleveland at the prices of August 1903. A movement in bullion, which could be induced in a variety of ways, might at any time prevent the consequences inferred from being actually realised. But from the money cost of production of

a number of commodities in England and other countries we could form an idea as to the industries in which each country possessed the greatest advantages in production—whether as a result of geographical, ethnological, educational, or other causes—and therefrom deduce the most probable lines of international trade. In the chapters which follow we have not hesitated to give numerous estimates of the money costs of production in different countries; but at the same time, while recognising the difficulty of the task, we have made an attempt to reach the root of productiveness by comparing directly, wherever possible, the efficiencies of the various factors in production. In addition to the question, What are the money costs of steel at Pittsburg and Cleveland?—highly mutable facts—we have inquired: How do the natural resources at the disposal of the two places compare? How do English miners, furnace-men, and steel workers stand in efficiency beside American labour? Is American management more enterprising than ours? Does it possess greater vitality; and how do the facilities for transport compare? From the answers to these questions much more can be learnt than from figures as to comparative prices. Yet the latter have their value in a certain setting, as we have noticed, and they give indications which, taken with other information, lead to the facts. In this fashion we have prosecuted our inquiries in all the chief industries.

The next point upon which we shall lay emphasis appears even more paradoxical than that to which attention has already been directed. It is that the most efficient producers do not necessarily export,

even supposing that their wisdom and knowledge of markets and needs is unexampled in its completeness. England may manufacture blankets at a lower real cost than Germany—our labour may be more efficient, our management more enlightened, and our capital may be fixed in more suitable forms —and yet the British manufacturers of blankets may be beaten in neutral markets and even in the home market—and it would pay this country to be 'beaten' in such a sense. This would hold good apart altogether from the effect of tariffs and the policy of 'dumping.' We may conclude, therefore, that those who would measure this country's economic decadence or advance must not only be sure that such figures as are employed by them do really represent what they pretend to represent, and are, moreover, comparable, but also be clear as to what exactly the facts so revealed imply with reference to the economic conditions of the countries to which they relate.

Assuming the imaginary state of affairs which we supposed to exist in an early passage of this chapter, we may show clearly how the doctrine laid down above is deducible from the conditions of international trade. 'The imaginary state of affairs,' be it noted, is abstracted in such a way that the doctrine elicited from it may be applied to the affairs of everyday life.

Let country A

produce $1x$ with 10 labour-capital units
and " $2y$ " " " " "

Let country B

produce $3x$ with 10 labour-capital units,
and " $3y$ " " " " "

Then, obviously, country B is more efficient than country A in the production of both x and y; but although country B manufactures y at a lower real cost than country A it is evident that B will be beaten, *cæteris paribus*, in her home markets by the goods of character y exported from A. B's advantage is greatest in the making of x, and it will pay her, therefore, to export x, taking y in exchange. It will also pay A to export y, taking x in exchange; since, reckoned in terms of x, country A possesses an advantage in the production of y. Consequently an enduring trade will spring up, A exporting only y, and B exporting only x, while in all probability the conditions under which the costs of production vary with the magnitude of the output may be such that it will be economical for one country or both countries to carry on the manufacture of the two commodities in some degree.

Prices, as Ricardo laid it down, will be rendered suitable to this state of affairs, for the precious metals 'are, by the competition of commerce, distributed in such proportions among the different countries of the world as to accommodate themselves to the natural traffic which would take place if no such metals existed, and the trade between countries were purely a trade of barter.'[1] Prices might rise all together in one of the countries, but if they rose, or the price of one commodity rose, the advance would be so reflected in the remuneration for labour that the workers of the country would be in a better position than they had been previously. The trade means large gains; but to

[1] Ricardo, *Principles*, ch. vii.

calculate at all exactly the distribution of these gains is a task beyond us. To indicate the influences under which their division takes place is no light undertaking; and, as it lies beside the immediate object of our essay, readers who would know something more of the operation of these influences must be referred to the exposition of the subject by Professor Edgeworth in the 'Economic Journal' in 1894.

If the theory of international trade, as set forth in broad elementary outline above, is fundamentally correct, it will be immediately evident that a country's trade may decline contemporaneously with the country's economic advance. Thus, let the state of our two nations be as described in the passage above, A exporting y and B exporting x, and the economic efficiency of each being such as the figures below indicate :—

Country	A	produces	$1x$	with	10	labour-capital	units.
"	"	"	$2y$	"	"	"	"
"	B	"	$3x$	"	"	"	"
"	"	"	$3y$	"	"	"	"

Now suppose industrial advance takes place in B, with the result that $6y$ can be created with the expenditure of 10 labour-capital units. What will be the effect? It is obvious that trade between A and B will entirely cease as soon as time is given for industrial organisation to accommodate itself to the new conditions, and for the distribution of the precious metals to have the requisite influence on prices. Concurrently, as the outcome of industrial and other social changes in other countries, C, D, and E, it is conceivable that the trade of A, her

economic efficiency being as before, or having even abated, may increase in vast proportions, while that of B under the new conditions diminishes. Yet it is B with the languishing trade which has really progressed.

It would be palpably absurd to urge that the possible case here described is usual or likely. It appears to us highly probable that under the circumstances of modern commerce the increase in quantity of a country's foreign trade per head of her population does usually indicate her advance in economic efficiency, counteracting causes such as the raising of tariffs, or co-operating influences such as cheapened means of transport, being supposed inoperative. We cannot here enter into the question as to whether economic progress is on the whole increasing or diminishing the differences between 'comparative costs of production,' so as to increase or diminish the proportion of foreign trade to home trade. At any rate we may say that the case treated above is one to be borne in mind, for at least it warns us against using the declining figures of trade, relating to one class or a few classes of a country's exports, as indices of that country's economic decay as a whole, or even in particular industries.

The line of argument hitherto traversed makes it apparent that industrial decadence itself would not, as a rule, tend to bring about that utter collapse of our manufactures and trade which has been pictured to us—the empty warehouses, the mills 'shut down,' the flooded mines, the vessels rotting at crumbling wharves. We should still import—according to the examples given above—then it is superfluous to add

that we should export also. Our factories would vibrate with the throb of machinery; operatives might still be seen weary with days of heavy labour, and docks and streets crowded with goods, and the confusion of bustling, if inefficient, activity. We should all have to work pretty much as before, there is every reason to believe, if not much harder, but we should receive for our labour a lower real wage. In fact, to carry the argument a stage further, we could form a better idea of our rise or decline in the past few years from an examination of the growth of income per head in general than from figures of trade. Here, then, it will be of service to quote Mr. Bowley's calculations[1] of the weighted averages of money wages in eight selected trades of importance, including agriculture, for various years since 1840. Beneath each average wage we have placed Sauerbeck's index number for the same year to give some indication of the trend of general prices, and therefore of the movement in real wages; but the reader must be reminded that the prices used by Sauerbeck are wholesale prices, and that no place is given to rent.

—	1840	1850	1860	1866	1870	1874	1877	1880	1883	1886	1891
Average money wages	61	61	78	81	88	97	94	89	92	90	100
Sauerbeck's index number	103	77	99	102	96	102	94	88	82	69	72

The advance in real wages, therefore, was probably fifty per cent. in this half-century. Again, the veteran

[1] *Wages in the United Kingdom*, 1900.

statistician Sir Robert Giffen has calculated that the value of the aggregate capital (broadly conceived and including land) possessed by the people of the United Kingdom has increased about fifty per cent. since 1885.[1]

Perhaps no figures are more dangerous to use than those relating to imports and exports. There are doubts as to the real facts represented by them and as to the comparability of different sets of figures. Identical figures may have a variety of meanings. Increased trade may mean progress or decline, though as a rule it means the former. The economic efficiency of countries is not proportional to their foreign trade. Such a proportion is not maintained for the reasons already given, because of tariffs, and because the natural obstruction offered to trade is greater for some countries than for others. The position of England, in close touch with the Baltic and the ports of France, Germany, and Spain, and as near to the New World as any other Western Power, is ideal. And the figures of imports and exports themselves must be used warily. The trustworthiness of some of them has been questioned, and the comparability of the figures for international trade offered by different countries, collected and calculated as they are upon diverse systems, has been rendered doubtful by discrepancies between the returns from different countries for what purports to be the same fact. Some treatment of this question would have been highly desirable; but the labour involved would have been considerable, and already a committee of the

[1] *The Growth of Capital*, 1889, and *Journal of the Statistical Society*, September 1903.

British Association for the Advancement of Science is preparing a report upon the matter. However, in what follows we have used figures with caution; we have only compared figures from the same source, and we have not formed our conclusions upon the evidence yielded by trade figures alone.

The theory sketched above, it might be said, ignores altogether some of the most significant features of modern international commerce. The actual cost of production to-day, it could be pointed out, in some cases plays no part in determining selling price or the destination of goods. To win a market, to avoid wasting a surplus, to realise the maximum net profit by selling at a high price at home and a low price abroad, goods are exported at prices which bear no relation to their cost of production. This is true, but to a less extent than is sometimes supposed; and the theory so far expounded holds good if 'supply prices' be substituted for 'cost of production.' 'Supply prices' mean the prices at which it will pay the producer to sell, either continuously or at some particular time, rather than not produce or waste what is produced. Normally 'supply prices' and 'cost of production' will tend to correspond; but correspondence is by no means certain when the home market is monopolised.

Of course we are referring now to the policy of 'dumping,' of which so much has been heard recently; and, although it is our intention to avoid as far as possible specific reference to the present fiscal controversy in placing the results of our review before the public, it seems necessary here to say a few words as to this particular feature of foreign trade.

If the home market be monopolised, it might conceivably pay producers to manufacture on a large scale and sell a certain quantity at a high price at home and a certain quantity at a low price abroad, arranging each year for an output in excess of the anticipated home demand at the price fixed upon by the monopolists. The maximum net profits might be realised in this way; but the amount which it might pay to sell abroad at the low price could not be indefinitely increased. And certainly, if the home market were monopolised, there would normally be a surplus produced, over and above the restricted supply required at home, in cases in which provision had to be made for the quantity of output some time before the home demand could be accurately gauged, and in cases in which the output of the industry could not be varied rapidly and cheaply. Again, a foreign producer might decide to lose money for a time with the object of 'winning' a new market. But the latter is a policy of doubtful value. It is costly; and it therefore implies combination or monopoly of some kind, since one firm would not spend much money on a plan which might benefit rivals as much as themselves. Moreover, can a market usually be 'won' for a long time by such a method? In the chapters which follow, instances will be found of markets being 'won' but promptly lost again when prices have been put up.

It is a curious circumstance that at the beginning of the nineteenth century Lancashire spinners were accused of selling yarns abroad *sub rosa* at miserable prices, that is, of 'dumping,' and that a vain attempt was made to induce the Legislature to check the

practice on the ground that the foreign manufacturers of cotton fabrics were thereby afforded an unfair advantage. It was urged then that England as a whole suffered from this early 'dumping'; that even the cotton-spinners suffered really in the long run, since their action curtailed the export of cotton fabrics, and therefore diminished the home demand for cotton yarn at good prices. To-day, on the contrary, there are many who believe that, while a country may gain by selling goods at a price at which the goods would not continue to be produced if it were the only price received, the country receiving such goods must lose. The grounds for such a belief, however, appear to be inadequate. Manufacturers using the dumped goods certainly produce at a lower cost, and, therefore, the ultimate consumers gain, so far as these goods have entered into the cost of production of the commodities which they consume. But it must be noticed that the gain may have been acquired at the cost of an increase in the home expenses of producing the commodities which compete against those that are 'dumped.' To our minds there is little doubt as to whether a balance of advantage is usually left or not.

If 'dumping' continued, the industries affected here would have to accommodate themselves to it and supply more elastic quantities to the market. This they should succeed in doing without great difficulty, for the commodities 'dumped' are not as a rule perishable, nor are they as a rule finished goods which could not be produced for stock. Hence unsteadiness of employment in this country need not result from our *making abnormally cheap foreign purchases occasion-*

ally. And, even if unsteady employment in some degree did result, we should have to weigh that disadvantage against the gain, and consider whether the development of a greater economic adaptability in our industrial population might not fully meet the situation, inasmuch as the 'dumping' would always stimulate some industries which were closely analogous in character to any that it might depress. It would be unfortunate if the country decided hastily to encourage rigidity and inelasticity in our industrial organisation. To argue that by suffering cheap imports of this kind we deliberately throw away the advantages of increased returns being obtained from production on a large scale in this country is to reason in an atmosphere of unqualified abstractions and away from the facts. Of such a consequence as an appreciable element there need be no fear in view of the magnitude of the industries affected, the comparative insignificance of the quantities that ever could be 'dumped,' and the limitations imposed on the size of a typical works by the conditions of efficiency. The present result is that the industries whose sales are checked by 'dumping' are rendered more risky and less stable—like farming in its dependence on the seasons and foreign crops. The man at the head of affairs must study the market and the conditions of production at home and abroad with more care. He must be far-sighted in his estimates. Gross profits may rise in consequence, some extra capital may be locked up in stocks, but severe losses and great unsteadiness in the business world need not occur. And, after all, the conditions are not so novel as the invention of a new term has

made them appear. Manufacturers in this country are 'dumping' here every day, and autumn and spring sales have not yet proved the ruin of the British employer and the undoing of the British operative.

Inasmuch as in the course of the following pages the wages earned in different countries will be occasionally quoted, it is desirable to state here, to avoid constant repetitions, what information exactly the figures yield and what information they may not be taken to yield. Averages may prove very misleading if they are not weighted, that is, if allowance is not made for the numbers of people who receive each rate of wages, when the variety of specific employments included is considerable, or when figures have been culled from many localities. Then, again, the number of days worked in the year and the hours of labour must be taken into account. In some cases we have quoted maxima and minima wages to show the relation between the range of wages in one country and that in another, but they alone cannot be said to afford any very distinct ideas of the relative state of affairs with regard to wages on the whole. Moreover, we must be sure that comparable kinds of work are referred to when wages are contrasted. This is an important point in view of the different systems of organising the labour factor in production which prevail. The wages, again, which are usually contrasted are those of the principal wage-earners, and they do not bear in different countries a constant ratio to the family wage. For example, it is declared that an American collier finds 77·5 per cent. of the family earnings, while a German collier finds

only 65·8 per cent. Again it is asserted that the proportion of the family income which is not provided by the chief wage-earner, in the case of the iron industry, is 10·9 per cent. in the United States, 13·9 per cent. in Germany, and as much as 40·6 per cent. in Belgium.[1]

In addition to these and other considerations of the same character, together with questions as to the manner in which the figures have been collected and calculated, the important distinction must be drawn between real wages and nominal wages. Real wages —that is, the sum of satisfactions derived by the workers from their wages, work, and concomitant circumstances—are the most important facts if our object is to compare the relative conditions of labour. Their amounts it is impossible to calculate with any degree of certainty, but there are certain obvious points to be observed when real wages are being computed. The workers in an industry established in country places will almost certainly be afforded the opportunity of supplementing the family's real earnings by keeping productive domestic animals and by cultivating a small patch of land. Again, the value of certain insurance benefits enjoyed by the workman may have to be added. In Germany, for instance, allowance must be made, not merely for the sums deducted from wages for compulsory insurance, but also for the contributions of employers and the State. And lastly, there is the cost of living.

The calculation of the cost of living is no easy matter. It involves some comparison of the different

[1] See Hasbach's article in Schmoller's *Jahrbuch*, 1903, part ii. p. 87.

ways in which incomes are spent, that is, of standards of life, and an examination of the prices of those goods which figure in working-class standards of living. Further, it would be a serious oversight to ignore altogether the question as to whether the family income is usually spent economically or not. It is probably true that the German housewife is a better manager as a rule than her English sister.

As regards the cost of such goods as are consumed by the working classes on the Continent, here, and in the United States, it is impossible to give any exact averages. It would appear, however, that the cost of living is higher in the United States than in England, chiefly because of high rents and in a less degree because of the high prices of certain commodities and services. As between England and the Continent any difference that may exist cannot be considered as at all significant. Nevertheless a German workman is able to subsist cheaper than an English workman; and it would no doubt be correct to add also that a British workman's family can live happily on a wage with which an American family of the same grade would feel pinched. The standard of living is higher here than in Germany. More meat is consumed per head, and the meat is of a superior quality: nearly twice as much is spent per head on meat in Great Britain and in the United States as in any Continental country. The consumption of wheat, flour, and sugar in England is also much above that of Germany but not above that of France. The French appear to make up for a low expenditure on meat by a high expenditure on wheat. The American has a higher expenditure on

food than the Englishman,[1] and probably the casual expenses of the former—for travelling and amusements—exceed those of the latter. But the British drink bill is a national disgrace. In 1898 it amounted to 154,481,000*l*., or 3*l*. 16*s*. 10½*d*. per head of the population. Yet, while the consumption of alcohol in this country is excessive, and far ahead of that in the United States, it falls below the consumption in most European countries. The annexed table, which is taken from Rowntree and Sherwell's work on temperance, gives the consumption per head of absolute alcohol in the countries stated:—

	gallons.
France	3·72
Belgium	2·81
Switzerland	2·64
Denmark	2·51
Spain	2·42
Italy	2·40
Germany	2·09
United Kingdom	2·05
Hungary	1·50
United States	1·16
Sweden	1·08
Russia	0·60
Norway	0·54

The figures are rough averages taken for two or more years within the period 1893–7 and based upon certain assumptions as to the percentage of alcohol in different beverages.

Of the house accommodation required by the working classes it is impossible to speak with any degree of scientific accuracy. The price of house accommodation, however, is certainly much more in the United States than here; as to this the Mosely

[1] See, *e.g.*, American inquiry of 1890–1.

commissioners were absolutely unanimous. In Germany rents may be somewhat higher than here; and no doubt the action taken by some of the municipal authorities to render cities healthier to live in, and more beautiful, must result in some advance in the prices paid for house room. But this we should hardly regard as a disadvantage under which the German workman labours.

CHAPTER II

SUPPLIES OF IRON ORE AND COAL, MINING AND COKING

In this chapter we shall attempt to estimate the supplies of iron ore and coal, together with their qualities, and to contrast the efficiencies displayed by different countries in respect of mining and the production of coke. Cheap supplies of coal of various qualities, we need scarcely remark, are at present essential to a country's economic development. To understand fully, for instance, the comparative international conditions in the iron and steel industries we must examine not only (*a*) the amount of work to be done in assembling materials at the furnace, (*b*) the cost at which this is performed, that is, the rates on railways, canals, and lakes, and ocean freights, and the charges for handling cargoes, (*c*) the cost of smelting, and (*d*) the cost of producing steel; but also (*e*) the natural resources, of which *coal* and *ironstone* are the chief, (*f*) the costs at which such material is raised, and (*g*) the price at which coke can be produced profitably.

Iron Ore

We shall begin with the distribution of iron ores and the methods of raising them. The following

quantities were mined in the chief iron-producing countries in 1900 in millions of metric tons of 2,204 lb.:—

United States	27·6
Germany	19·0
United Kingdom	14·0
Spain	8·7
Russia	6·2
France	5·4
Austria-Hungary	3·5
Sweden	2·6

In the figures below the relation of imported ore to that raised in the consuming country is shown:—

Average for Three Years ending 1882, *in Millions of Metric Tons.*

—	United Kingdom	Germany	United States	France	Belgium
Ore raised	17·9	7·7	7·0	3·2	·21
Ore imported	2·8	·67	·62	1·4	1·61
	20·7	8·37	7·62	4·6	1·82

Average for Three Years ending 1900, *in Millions of Metric Tons.*

—	United Kingdom	Germany	United States*	France	Belgium
Iron ore raised	14·4	17·9	27·1	4·8	·22
Iron ore imported	6·4	3·4	·59	2·0	2·5
	20·8	21·3	27·69	6·8	2·72

* Average taken for 1899, 1900, 1901.

The introduction of the basic process has caused the opening up of the iron ore deposits of Luxemburg and Lorraine. 'On calculating,' wrote Dr. Wedding, 'how far the needs of the individual countries can be met by their own ore supply, it will be seen that only the United States and Germany have a sufficient supply of iron ore to enable them to manufacture their pig iron without the necessity of procuring

supplies from abroad. In reality, however, the United States alone are doing this.'[1] But Germany's exports of ore almost balance her imports, and Dr. Wedding might have added that Russia[2] is in the same position as the United States in this respect, though Russia's output of ore is only about one-eleventh that of the United States. In 1870 England imported but 1 per cent. of the ore used by her furnaces; now she imports over 40 per cent.; hence such of the iron industry as does not lie near a port is tending to shift to the coasts to meet the supplies of ore which are procured from Bilbao and Swedish Lapland.

Belgium imports almost all its ores from Luxemburg. The Germans, while importing some ores, obtain most of their supplies from Luxemburg, Nassau, and Lorraine, but the ore deposits in these regions are not very rich and they have to be carried long distances. According to evidence recently given by German authorities, the richer grades of Minette ores in Lorraine are likely to be exhausted in about two years, and at the end of that time the average percentage of iron in the German ores is expected to drop to 30 per cent. (from 32 per cent.), which will raise the cost of pigs about 1*s.* 6*d.* per ton.[3] But all estimates of this kind must be regarded as more or less doubtful.

The iron and steel industry of the United States

[1] Quoted by Brugmann in his paper to the Iron and Steel Institute at Düsseldorf in 1902, pp. 5, 6.

[2] It is calculated that 80,000,000 tons of ore still remain untouched in Russia.

[3] Report of the delegates of the British Iron Trade Association who visited Germany in 1896, p. 10.

is located mainly in two places, (*a*) Pennsylvania and Eastern Ohio, and (*b*) Alabama and Tennessee. Far the larger part, however, is in the former district. The ore for the Southern industry is found on the spot, but most of that smelted in the Northern furnaces is conveyed from the deposits lying south and west of Lake Superior by the lakes and railways, a distance in some cases of about 1,000 miles. More than 20½ million English tons of ore were mined in the Lake Superior ranges in 1901, whereas the Southern States yielded only 4¾ million tons, and other States 3½ million tons. The bulk of the Lake Superior ores which are at present worked are sufficiently free from sulphur and phosphorus to be suitable for conversion into acid steel, and they are in addition rich in iron; but the supplies of the best Bessemer ores are probably being rapidly exhausted, so that in the not distant future the basic process may have to assume a more important place in the American steel industry. In general, however, the deposits of ore in the United States in the places already worked are said to be immense. The United States Steel Corporation alone is stated by Mr. C. M. Schwab to possess property containing some 600,000,000 tons at least: it owns forty-eight mines in the Lake Superior district, which produced 12,725,000 long tons in 1900. New discoveries are being made every year in the old districts, and several places further West are expected to prove rich in iron. It has been said that the American supplies will last for seventy or eighty years at the present rate of exhaustion; but as the whole of the deposits in the United States are certainly not known, no limits can

be laid down. In the Old World the only fields at all equal to the Lake Superior ones are those of Luxemburg and Lorraine, which are said to contain together some 177,000,000 tons. From the latter nearly nineteen million tons were procured in 1900; but they consist entirely of phosphoric ores, in which, moreover, the percentage of iron is less than that in the Lake Superior ores. With regard to the supplies of ore which may be reached economically by the industry in England, it should be observed that in addition to its own unexhausted fields and the deposits at Bilbao there are immense resources almost unworked up to the present in Swedish Lapland, from which the cost of transport to our furnaces will be no greater than that of Spanish ores.[1] Spanish ores cost at the Tees-side furnaces about 16*s.* a ton on a 60 per cent. sliding scale, and the average price of Mesabi ores at Pittsburg between 1899 and 1901 was 16*s.* 4*d.* per ton.

The outputs of iron ore per man about the early 'eighties' were in the United Kingdom 500 to 525 tons, in France 357 tons, in the United States 330 tons, and in Germany 213 tons.[2] It goes without saying that all figures of this kind are liable to prove misleading, since the results are so much affected by differences in the number of hours and days worked and in wages earned—a strike, for instance, in one

[1] Attempts are now being made in Norway and some other places to utilise low-grade ores by crushing them, separating the metallic matter by powerful electro-magnets, and making up the result in briquettes. Mr. Edison recently said that he expected 'to be able to deliver briquetted concentrates containing 68 per cent. of iron in ship at Middlesbrough at a net cost of 11*s.* per ton.' These experiments, however, cannot be regarded yet as of any appreciable economic importance.

[2] Bell's *Iron Trade of the United Kingdom &c.*, p. 78.

country or a period of short time would render them incomparable—and the output per man is determined as much by the situation of the ore, which may be most inconvenient in some localities, as by the efficiency of the miners. Between 1873 and 1893 the annual average output of ironstone per man advanced from 200 to 329 tons in Germany, and from 750 to 876 tons in Cleveland. The rate of increase was therefore 64·5 per cent. in Germany and only 16·8 per cent. in Cleveland. But it must be remembered that the introduction of the basic process has recently caused use to be made in Germany of deposits which were previously unworked or worked only to a slight extent. And one would be inclined to infer from Sir Lowthian Bell's comparative investigations that the Germans were very backward in respect of mining enterprises some thirty years ago. Certainly the wages of German ironstone miners are much less than those of English miners of the same character. Here in 1902 hewers earned on an average 6*s.* 6*d.* a day, while other underground workers received from 4*s.* 9*d.* to 5*s.* 3*d.* a day and those working above ground were paid from 3*s.* 9*d.* to 4*s.* 6*d.* In Germany in 1901 the average daily wage of a hewer stood at about 3·44 marks in Siegen (Nassau), and at 3·14 marks and 2·73 marks in districts on the right and left of the Rhine respectively. Other underground workers in these three districts, taken in the above order, received 3·16, 2·98, and 2·64 marks each, while the corresponding workers above ground earned 2·96, 2·65, and 2·38 marks.[1] The above figures for Germany represent the wages paid after deductions

[1] See Hasbach's article in Schmoller's *Jahrbuch*, vol. ii. 1903.

have been made for insurance; they must be increased by about 11 per cent. when allowance is made for the value to the workman of the existing insurance arrangements.

In the United States much of the Mesabi ore can be won as easily almost as gravel. It is dug from cuttings by huge steam navvies and loaded direct on to the trucks which convey it to the lake side—one of these steam shovels loaded 170,000 tons in twenty-six days—or it is worked underground largely by the caving process. As a result Mesabi ore can be procured at the mine for the low cost of 1*s*. to 2*s*. 6*d*. a ton. It is even said that cost sheets in 1896 of cave-working, which is necessarily more expensive than shovelling the ore from the surface, showed expenses all told ranging from 37 to 41 cents per ton. In 1890 the cost of producing one ton of Michigan ore was five times this amount.[1] While English ores are not to be won so easily they are mined admirably. A correspondent of the 'Iron Age' (an American paper), who visited Cleveland, reported that the method of working there was excellent, and that the shafts were, as a rule, well equipped with modern machinery.[2]

We have met with no evidence to convince us that the American ore miner is more efficient than the English miner, or that his conditions are better, though undoubtedly his wages are higher. Indeed, American miners are generally Austro-Hungarians or Finns; in the Minnesota mines only 10 per cent. of the hands speak English. Moreover, as most of the open mines are worked only during the summer

[1] Foreign Office Report on the American Tinplate Industry, 1897.

[2] *Iron Age*, September 13, 1900. A good account of ore-mining in America will be found in a consular report of 1903 on the ore industry of the United States.

—for in the winter conditions are unfavourable for mining operations, and the lake route eastward is closed—the hands must seek other employment for a part of the year. Lumbering and farming are said to afford occupation to many of them.

Coal

And now let us turn to the question of relative coal supplies[1] and relative efficiency in the raising of coal.

World's Production of Coal (in short tons of 2,000 lb.) in the years 1875, 1885, 1895, and 1900. (Unit: 1 = 1,000,000.)

—	Quantities				Percentages			
	1875	1885	1895	1900	1875	1885	1895	1900
United Kingdom	144	184	228	252	48	40	32	29
United States	55	115	214	270	18	25	30	32
Germany	53	83	132	165	18	18	19	20
France	18	25	33	37	6	5	5	5
Austria &c.	14	24	37	43	5	5	5	5
Belgium	17	20	24	26	5	4	3·5	3
Other countries	1	13	37	53	—	3	5·5	6
Total	302	464	705	846	100	100	100	100

As affording some idea of the cost of raising coal in different countries we may quote here average prices and average outputs per head.

The average prices per ton of 2,240 lb. at the pit's mouth were as follows from 1896 to 1900:—

—	1896	1897	1898	1899	1900
	s d	s d.	s d	s d.	s d
United Kingdom	5 10¼	5 11	6 4¼	7 7	10 9¾
Germany	6 11	7 1½	7 4½	7 9¼	8 10
France	8 8¼	8 8½	9 0	9 11¾	12 0¼
Belgium	7 7¼	8 2½	8 9½	9 11¼	13 11¼
United States	4 9¼	4 7½	4 5	4 8½	5 8¾

[1] See note at the end of this chapter.

English Colonies.

—	1896		1897		1898		1899		1900	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
N.S. Wales	5	9	5	7	5	5	5	9	6	1
Victoria .	10	0	9	2	8	6	8	8	9	7
Western Australia	—		—		10	0	9	7	9	8
Queensland	8	4	7	10	7	5	7	1	7	0
Tasmania .	8	0	8	0	7	11	7	11	8	7
Total Australia	6	2	5	11	5	9	6	1	6	4
New Zealand	10	10	10	0	10	0	10	0	10	0
Canada .	8	11	8	11	9	1	9	1	10	11
Cape Colony	—		16	0	15	10	15	9	17	8
Natal. .	10	0	10	0	9	0	8	6	20	0

Quantity of Coal produced (in English tons) per person employed in the three chief coal-producing countries from 1883 *to* 1901.

Year	United Kingdom	Germany	United States
	tons	tons	tons
1883 . .	333	270	No information
1884 . .	322	267	"
1885 . .	319	267	"
1886 . .	315	267	"
1887 . .	318	278	"
1888 . .	321	290	"
1889 . .	315	281	421
1890 . .	297	268	443
1891 . .	285	260	453
1892 . .	272	247	468
1893 . .	247	254	448
1894 . .	274	256	405
1895 . .	278	260	450
1896 . .	291	271	448
1897 . .	299	271	450
1898 . .	294	269	490
1899 . .	311	268	552
1900 . .	296	264	548
1901 . .	278	—	—

Production per man (in English tons) of France, Belgium, and Russia.

Year	France	Belgium	Russia
1883	189	171	154
1888	217	186	196
1893	194	166	158
1898	218	180	174
1900	206	177	161

* In 1899.

We must remind the reader again, as we did when quoting analogous figures for ironstone mining, that outputs per head, even when allowance is made for the different methods of working and the actual hours worked, do not measure the relative efficiencies of labour and organisation because of the different degrees in which coal is accessible. Moreover, we doubt whether much may be inferred in many cases as to the capability displayed in the mining industry as a whole from the rate at which the outputs per head increase or decrease: deepening mines, short time, and unusually good employment are disturbing factors which are generally operative.

Taking the five countries which are most advanced industrially, we find that in 1900 the relation of their production to their consumption and trade could be expressed thus in millions of short tons:—

—	Production	Imports	Exports *	Consumption	Consumption in tons *per capita*
United States	268·2	2·3	7·6	262·9	3·46
United Kingdom	252·1	Insignificant	58·0	199·1	4·79
Germany .	120·4	17·7	20·4	117·7	2·09
France .	36·5	16·0	1·3	51·3	1·33
Belgium .	25·7	4·1	8·1	21·7	3·26†

* Figures for export sometimes include bunker shipments and sometimes they do not. Coke and patent fuel are also taken into account in some cases. But these discrepancies cannot affect the results substantially.

† The *per capita* consumption of Austria Hungary was 35 in 1889, and of Russia 12 in the same year.

While American coal is cheaper than English, it is said to be inferior as a rule, and there seems little fear of American bituminous coal at any rate finding a large market in Europe for some years to come, especially in view of the heavy cost of carriage

across the Atlantic. American coal has been taken at Havre, but the importations of 1900 were not repeated in 1901 or 1902. 'The explanation,' we are told in an official report, 'is to be found in the fact that British coal is preferred to American coal by the French importers on account of the greater proportion of large pieces which it contains. American coal is much more friable than British coal. Insufficient allowance is apparently made for this in the method of loading the coal in the American ports;[1] and after its transit across the Atlantic in large cargoes, it arrives in France with a considerably larger proportion of fine coal or dust than is contained in the cargoes of British coal to which the French consumer is accustomed. British coal is not only more durable in itself, but is brought a short distance in small steamers, and the tendency to disintegration is thereby much lessened. Moreover, the business relations between the British coal owners and the French receivers, extending over a period of many years, make the latter disinclined to alter their present arrangements unless there should be some strong reason for doing so. As a general rule the British coal owners allow easier terms of payment than the Americans, who are not inclined to give a long term of credit. For these reasons the margin between the prices at Havre of American and British bituminous coal is not sufficient to allow of the importation of the former, in

[1] To prevent the smashing of the coal in loading, the Brown coal-tipple is coming into use in the United States. The truck is lifted bodily, and slowly turned over so that the load slips lightly into a steel hood which has been placed above it, and which is then lowered into the hold of the vessel, where it deposits its cargo by the opening of its bottom. A method of the same general character is used in loading at Cardiff.

any great quantities, into the Havre consular district, and the price of American coal must be still further reduced before it can compete successfully with British coal in the North of France.'

There appears to be more chance of American anthracite winning its way in European ports. It is not so much liked as English anthracite, but it is much cheaper. The situation is illustrated in the following extract. 'A well-known Berlin coal merchant, who deals specially in anthracite, recently ordered a sample cargo of Pennsylvanian anthracite, in the hope that this might turn out to be a new means of supply. The expectations entertained have not been altogether fulfilled. American anthracite has not found the welcome that was expected for it. The fault, however, seems to be, not in the anthracite, but to lie in the ignorance of the consumer: American anthracite is much harder than British, and requires larger stoves and a greater supply of oxygen, and German stoves are not constructed for this kind of combustion; the American coal, too, leaves more ash, 14 to 16 per cent., compared with 7·8 per cent. in British coal. This ash must be more frequently removed, or the fire goes out; it has, however, the advantage of containing little or no "clinkers." In spite of these drawbacks it is certain that Germany in the future will be largely dependent upon American anthracite, for the United Kingdom can scarcely supply her home demand in this article, and prices are constantly rising. Lately offers of anthracite have come from Russia; the chemical analyses have proved satisfactory, but the great difficulty and expense of

obtaining the supplies from the Black Sea render it doubtful whether Russian coal will be able to compete successfully with other supplies.'

The conclusion of this extract naturally leads us to inquire whether Russia will enter European markets as a coal producer. Some have thought it not impossible, and recently, at a special meeting of colliery representatives and others at Kharkoff, a paper was read, according to a consular report, showing that Russia might export coal with advantage. It was said, for instance, that the relative costs of placing Russian and British coal at Marseilles were 19*s.* 4*d.* and 1*l.* 1*s.* 8*d.* However, in these calculations certain charges were omitted, as regards Russian coal, and others were taken too low, while the figures for Great Britain all tended to the side of over-estimation. Our representative concluded that the prospects of Donetz coal being largely exported were not very promising, but that a sharp decline in the importation of coal through Odessa and other Black Sea ports might be expected.

A comparative analysis of Welsh and foreign coals made by Mr. F. G. Treharne, of Cardiff, is stated below. Mr. Treharne says that for marine purposes 'the practical working value of a coal is in direct relation to the quantity of fixed carbon it contains, commensurate with its having a sufficiency of bituminous matter to allow of its burning freely and readily in an ordinary steam-boiler furnace.' The best Welsh coal is taken as the standard of comparison, the analytical composition of which is fixed carbon 81·5, volatile matters 13·5, ash 4·0, moisture 1·0.

Cardiff	French	German	Indian	Japanese	Borneo	Australia	New Zealand	North America
carbon 81·5 or	carbon 62	carbon 72	carbon 50–55	carbon 46	carbon 45	carbon 55	carbon 55	carbon 68
100	76	88	61-68	56	55	68	68	84

General commercial types of coal were taken, not the best samples.

Welsh coal is the only coal that is shipped to the East to any extent: in 1900 nearly 85 per cent. of the coal sent to the east coast of Africa, India, and the East proceeded from the Bristol Channel.

Nowhere have the prospects of our foreign trade in coal been more exhaustively handled than in the paper read by Mr. D. A. Thomas to the Statistical Society in 1903. His conclusions will now be stated. Up to the present, British coal has almost held a monopoly in the Mediterranean and French ports, and the only serious competition now is that offered by Germany. In 1900 prices were high in the United Kingdom, and America (as we have already remarked) 'invaded' the European market, but in Mr. Thomas' opinion the invasion was merely an episode. At the Russian ports on the Black Sea a heavy import duty prevents almost any British coal from being received now; and some fear is entertained that the demand from Italy may fall off owing to the employment of water-power there. Germany competes with us in sending coal to the Baltic, but the mass of the Baltic trade still rests with the Tyne ports. The market in South America is important and is increasing, but the Indian market is less than it was forty years ago, and India is competing against us in Ceylon, Aden, Singapore, and Mauritius. Thus Mr. Thomas concludes as to our trade prospects.

Great Britain is well supplied with accessible coal, the unexhausted amount of which has been estimated at 60,000 to 80,000 million tons, but our stores are small in comparison with the amount that must be procurable from the coal fields of the United States, which are some twenty times greater in area than our coal fields. And the United States possesses in addition large supplies of petroleum and natural gas.[1]

British coal lies at all conceivable angles; faults are more frequent here than in the United States, and coal rests here at greater depths as a rule. In America a depth of 200 feet is considered fair, but in England a pit of three times that amount is regarded as shallow; again, in England more combustible gas is met with. Hence mining in this country, subjected as it is to a heavier charge for keeping the pits free from water, the general disadvantages of working at great depths, and the difficulties thrown in the way of electric machinery by the prevalence of combustible gas, is more costly than in the United States. However, as we should expect, since confronting and surmounting difficulties create efficiency, mining engineers are said to be more successful here than in America in dealing with shaft mines.[2]

While considering the American supplies of coal we may remark that the proportion of bituminous to anthracite mined has steadily increased. In 1880 the production of the United States was 25·6 million long tons of anthracite and 38·2 of bituminous; in 1881–5 the average quantities were respectively 32·6

[1] See note at the end of this chapter.

[2] See the *Engineering Magazine* for June 1902.

and 63·2; while in 1901 the anthracite, almost the whole of which was procured from Pennsylvania, amounted to 60·2, and the bituminous to 201·6 million long tons. The explanation is the deficiency of the anthracite coal and also that the invention of smoke-consuming devices has rendered the substitution of cheap bituminous coal for harder coal more satisfactory than it proved formerly.

In systems of mining the United States stands now in some respects ahead. It is a significant fact that while America employed 3,907 coal-cutting machines in 1900, England could number only 311 in use, and German coal owners had only just begun to consider them seriously. However, it must be remembered that electric driving is cheaper and more convenient than pneumatic driving, but that the former is at present regarded as too dangerous for use in many of our mines, in which combustible gas is constantly met with. The chance of explosions in bituminous mines when electric power is used has recently been emphasised by the Chief Engineer of the State of Pennsylvania, who expresses the hope that this form of power will ultimately be supplanted by compressed or liquid air. Moreover in England the so-called long-wall system of mining is widely practised, and many of the machines employed are therefore heavy long-wall machines; whereas of those in the United States a large proportion is of the cheap and light pneumatic percussive type. Still this does not explain away the difference, since 23 per cent. of American coal was worked by coal-cutting machines in 1900 (and nearly 25 per cent. of the bituminous coal), whereas

the percentage of English coal dealt with in the same way was as trifling as 1·48. In England such machines as are employed are to be found chiefly in Yorkshire and Scotland. In the Midlands only seventy-one such appliances, dealing with 670,600 tons of coal—that is, some ·03 of our total output—were at work at the end of the last century.

It would be presumptuous in us, without any claims to expert knowledge, to hazard a definite conclusion as to the insignificant part played by machinery within English mines. One cause, perhaps, consists in the peculiarities of our mines. Another, in respect at least of electric machinery, is our care as a nation of human life. Others of some weight may be the attitude of British colliers to labour-saving appliances, and the attitude of colliery proprietors, who are too prone to rest satisfied with the industrial methods to which they have grown accustomed. But whatever the main causes may be, coal-mining in the United States is more advanced than it is in this country, in that it has become in a higher degree a machine-using industry. At least it may be gravely questioned whether the possibilities of quicker and cheaper methods being employed in our coal mines have received adequate attention.

Even in the United States the introduction of coal-cutting machinery, which is far more extensively employed there than in any other country in the world, has been comparatively recent. In 1891 some 545 of these appliances were at work; by 1899 they numbered 3,125, the next year 3,907, and by 1901 as many as 4,341. About one-fifth of the

American output to-day is won with machinery, and the amount so acquired is nine times greater than it was ten years ago. The use of coal-cutting machinery is said to have reduced the cost of coal-raising between 15 and 17 per cent.: it was found that with the machines about sixty-four men could do the work for which 100 would be needed if their labours were unassisted. We should notice, moreover, that compressed-air locomotives and electric motors are rapidly taking the place of mules for underground traction in America. The advantages of electric motors in particular, where they can be introduced safely, appear to be considerable, not only on account of the low cost of traction per mile, taken in conjunction with the speed, but also because they can penetrate galleries which neither mules nor compressed-air locomotives could enter—the former because of their height, and the latter because their length prevents them from taking sharp curves.

The following figures certainly indicate increasing economies in coal mining in the United States, for which the use of machinery is in some degree accountable :—

—	Persons employed [1]	Millions of tons (2,240 lb.) of coal produced	Tons produced per person employed	Value of product per person employed	—
U.K. . .	479,000	159·3	333	85·8	1885
U.S.A. .	300,000	99·0	330	110·4	1885
U.K. . .	688,000	188·3	274	91·2	1894
U.S.A. .	376,206	152·4	405	101·9	1894
U.K. . .	708,700	220·1	310	117·7	1899
U.S.A. .	410,635	226·6	552	128·4	1899

[1] As to the nationality of American colliers, the accompanying figures

Undoubtedly one important reason for the rapidity with which new ideas make their way into general application in the United States is the openness of the average American about his business methods. It would be too much to say, as the American phrases it, that 'every door is upon the latch'; but as a rule the American employer does not take much precaution to keep his technical improvements secret. Perhaps Americans really enjoy acting the part of showmen of their own achievements: or one important cause may be a public-spirited pride in industries which are regarded as national triumphs. Certainly the Americans are not convinced that they lose by instructing their competitors; and the natural result of the rapid spread of new ideas is that the subsidiary ideas speedily follow by which a new departure may be rendered of great economic importance. As technical improvements spread rapidly in America, industry tends to develop quickly as a whole. Another country might invent as much, but if its people were dominated by the instinct of secre-

are interesting. Of the 37,000 hands engaged at coal mines in Illinois the percentage of each nationality employed was:—

Americans	48·12
English	9·40
Scottish	3·91
Irish	5·77
Welsh	1·79
German	11·45
French	1·03
Italian	3·35
Austrian and Bohemian	2·70
Hungarian	2·14
Poles	5·90
Belgian	1·35
Russian	1·38
Danes, Swedes, and Norwegians	1·71

tiveness it could not move so fast. In coal mining, no less than in other industries, this give-and-take is to be met with in the United States; hence the remarkable increase in the use of coal-cutting machinery in the short space of nine or ten years. A manager of a coal mine in America stated that he visited all the leading mines in the States before starting to equip his own, and frankly acknowledged that he obtained several of his ideas from one particular mine where he was given every assistance and information. 'This great broad-mindedness, which there is even among trade rivals, is very remarkable. It certainly is an immense help to the nation as a whole, and no doubt has other good effects as well,' wrote the commissioner from the 'Colliery Guardian' who visited the United States in 1901.[1]

The use of coal-cutting machinery is said to have had an important effect in diminishing the dangers of mining, and the following figures would certainly appear to support such a conclusion :—

—	Percentage of coal dealt with by coal-cutting machinery	Death rate from accidents per 1,000	Death rate from accidents per 1,000,000 tons raised
Ohio . .	41·35	2·14	4
Pennsylvania	29·67	2·43	3·73
Colorado .	11·03	8·99	6·83
West Virginia	9·27	5·03	7·20

However, it must be observed that the high rate of fatal accidents and the absence of coal-cutting

[1] *Colliery Guardian*, August 2, 1901. Two series of valuable articles, to which we are greatly indebted, appeared in this paper, the one dealing with coal-cutting machinery in Great Britain, the other with coal-cutting machinery in the United States. On the subject of coal mining see also the consular report of 1903 as to the United States and the extracts from diplomatic and consular reports on coal issued in 1903.

machinery may be joint effects of the same cause; and no doubt one general cause of both these facts in certain districts is the low level of economic development. In the matter of fatal accidents among colliers, England, which led the way with legislation, compares very favourably with the United States. The Americans are notoriously careless about taking precautions against accidents: in coal mines, the Chief Engineer of Pennsylvania has recently reported, numerous deaths are occasioned by workmen coming in contact with live wires when electric power is employed. From the figures below it will be observed that the life of the coal miner is safer in this country than beyond the Atlantic:—

	Fatal accidents per 1,000 employed		Death rate from accidents per 1,000,000 tons raised	
—	United Kingdom	United States*	United Kingdom	United States
1891	1·51	3·30	5·29	7·03
1892	1·48	2·51	5·41	5·27
1893	1·55	2·46	6·46	5·53
1894	1·59	2·47	5·99	6·02
1895	1·49	2·63	5·50	5·82
1896	1·48	2·78	5·25	6·27
1897	1·41	2·31	4·84	4·99
1898	1·28	2·54	4·49	5·02
1899	1·25	2·98	4·16	5·20
1900	1·29	3·32	4·51	5·94

* These figures relate to the chief coal producing States.

Neither of these sets of figures, it should be noticed, indicates the relative amount of danger associated with mines here and in the United States, for in the United States the number of colliers required in each mine has been reduced by the use of coal-cutting machinery, and, as regards the second set of figures, the coal might be more easily won, and

therefore more rapidly worked, in one country than in the other.

With the figures above compare the following:—

Fatal Accidents per 100,000.

—	England	Prussia*	France	Belgium
1861–70	334	282	301	260
1871–80	239	289	227	245
1881–87	192	308	157	219
1900	129	219	142	105
1901	136	222	121	—

* German Empire.

Another point of some interest in connection with the American coal trade is the erection of a coal elevator at Baltimore by the Baltimore and Ohio Railway Company in connection with the Baltimore Storage and Distributing Company. This erection is 150 feet long, 40 feet wide, and 50 feet high. 'It is intended to run the coal cars into the yard attached to the elevator and dump their contents into pockets. Conveyers similar to those used in grain elevators take the coal from the pockets and place it in bins in the elevator, of which there are twenty with a capacity of 200 tons each. To each bin there are two shutes, with accompanying screens, down and over which the coals pass to carts run under the bins. An electric plant will be installed to run the machinery, and it is said that the handling of the coal will be practically noiseless. The cost for handling coal by men with shovels is about 1*s.* 7*d.* to 2*s.* per ton; but it is claimed that with this system the elevator can do it at a profit at 10*d.* It is intended to use the elevator principally for the distribution of anthracite coal to be used in private

houses. Two similar elevators in other sections of the city will, it is said, be built very soon.' Here we have one of the many examples of the excellence of industrial organisation in America, particularly in matters of transport.

Most of the coal used for the Northern furnaces in the United States comes from the Connellsville region to the east, some fifty to ninety miles away, where it is first coked. It is easily procurable, of good quality, and its price on an average during the last twenty years has been little more than half that of Durham coal. It can be delivered at the pit mouth for 2*s.* 1*d.* per ton of 2,000 lb. (but whether much has actually been sold at that price is open to question), and yet the wages earned by Connellsville miners have exceeded those of Durham by about 100 per cent. All American coal, however, is not so cheap. The average prices per English ton at the pits' mouths here and in the United States for the last twelve years of the nineteenth century are stated below :—

	United Kingdom		United States	
	s.	*d.*	*s.*	*d.*
1889	6	4¼	5	8½
1890	8	8	5	2¼
1891	8	0	5	8½
1892	7	3	5	4¾
1893	6	9½	5	4
1894	6	7½	5	1
1895	6	0½	4	9¼
1896	5	10	4	9¼
1897	5	11	4	7½
1898	6	4	4	5
1899	7	7	4	8½
1900	10	9¾	5	8¾

According to Nasse the available coal store of Germany is probably as follows [1] :—

[1] See note at the end of this chapter.

District	Milliard tons
Ruhr	50
Saar	10·4
Aix-la-Chapelle	1·8
Upper Silesia	45·0
Lower Silesia	1
Kingdom of Saxony	0·4
Other small basins	0·4
An aggregate of	109

Westphalia and Durham are about equally well placed in respect of proximity to the iron and steel industries which they serve with coal respectively: the Belgian and French iron and steel industries have to pay more, as a rule, than their English or German rivals for the carriage of fuel.

About the early 'eighties' the miners of Great Britain raised per head 24 per cent. more coal than those of Germany, 75 per cent. more than those of France, and 95 per cent. more than those of Belgium,[1] although the English in all cases laboured shorter hours. These differences were not of course entirely due to the differential capacities of the miners; but Sir Lowthian Bell, nevertheless, was strongly of opinion 'that the superior results of the English miner must be ascribed, in a great measure, to his better pay and better living.'[2] Sir Lowthian Bell also estimated that the costs of labour in mining (taking coal and ore together) were in the following proportions about 1880, though English wages were much the highest: Germany, 95; England, 100; France, 103; and Belgium, 124.

Since 1880 coal mining in Germany has developed in an extraordinary degree:[3] in 1880 the total pro-

[1] Bell's *Iron Trade of the United Kingdom &c.*, p. 68.
[2] *Ibid.* p. 86.
[3] Brügmann, *op. cit.*

duction was about 47 million tons, whereas in 1900 it was nearly 150 million tons. But the output per employé is still less in Germany than here, and the cost of coal in Germany is generally higher. Calculated for the ten years 1891 to 1900 the average annual output per employé was 262 tons in Germany and 284 tons here. We have, therefore, lost ground relatively, but the change may be due partly to physical conditions and partly to the great scope in Germany for improvement in mining twenty years ago.

Our coal may be a little easier to win;[1] but some part of the difference in the output per head is no doubt traceable to the greater efficiency of the English collier. In a Foreign Office report of 1898 on the coal industry of the Rhenish Westphalian Provinces we read:—'Although wages are doubtless lower than in England, even in this district, where they stand higher than in any other part of Germany, I think it will still be found on the average that the working effect per coal hewer and shift is only about half what it is in England, for the following reasons, because the English pitman lives better, works with more judgment and skill, and once he has made his conditions gives his greater labour power more freely; and last, but not least, he is a trained hewer or timber setter or putter, as the case may be. In Westphalia the development of coal mining has been so rapid . . . that new hands had to be recruited from all parts of

[1] Certainly our coal is easier to work on the whole than the Belgian coal. A recent report has shown that the average thickness of the seam in Belgium is only 2·09 feet, and the average depth of mines is some 1408 feet. See *Report of the Delegation organised by the British Iron Trade Association*, pp. 8, 9.

Germany, Poland, and Holland, chiefly common labourers, and from the northern parts of Italy, a superior class for stone-drifting work, the latter fine, stalwart, honest, fearless, hard-working men. Of course there is the old "Stamm" of trained Rhenish Westphalian pitmen to make the thing possible: from this class the overmen and deputies are selected; hence it is, and in consequence of the large numbers of off hands that have to be employed (by reason of the number of working levels, inclines, cross-cuts in the steep and varied dips of the coal measures, and of the large number of hands employed overground at coal washing, screening, and at the great number of engines), that the general working effect per man and day is so low, *i.e.* per head and ton of coal extracted.'

Again, there is the evidence of Mr. Ernst Dückershoff, a German miner, who came over to this country and worked in Northumberland. In his opinion the English collier is more efficient and is better paid and more comfortably situated than the German. Speaking of colliers here who are advanced in years he says:—'I once worked alongside of them for three months. There were thirteen of them—the youngest sixty-three, the eldest seventy-five—and I really must say that several of them would have beaten a German miner between thirty-six and forty years old in point of activity. There is good reason why the English miner should be the older and stronger man of the two. He has time to rest properly, and he enjoys more meat than potatoes. Generally speaking, overstrain and underfeeding disable the German from competing with him.'

Mr. Dückershoff notes with satisfaction that easy 'stalls' are reserved for the elderly men, so that they may make a living, and that this practice causes no jealousy. Again, he observes the good habit of settling stalls by lot, so that an unpopular workman cannot be victimised by the overseer, as he may be in Germany. 'The regulations enforced in the various mines are not like the German ones, and do not bristle with penalties.' 'No German who is in work here has any longing to return.' In talking with Germans in England he frequently heard it said, 'Germany is all very well if one has English money to spend in it.'[1] However, as Mr. Dückershoff was compelled to leave Germany because the active part taken by him in trade unions had rendered it impossible for him to obtain employment in his native land, and as, moreover, his views appeared originally in a German newspaper in the form of articles which were certainly not designed to allay discontent on the part of the German working classes, scientific accuracy undisturbed by bias cannot be attributed to his statements.

As to wages, Mr. Dückershoff writes:—'My monthly average in Germany was eighty marks (3*l*. 18*s*. 4*d*.). Here I received during 1895, according to the colliery books, 77*l*. 11*s*. 7*d*. It must be admitted, however, that I was favoured, because I had to fetch my wife and four children out of Germany.' Compare with these figures the following table prepared by the British Iron Trade Association for the Labour Commission in 1892, that is, some

[1] *How the English Workman Lives*, by a German coal miner (Ernst Dückershoff), 1899.

three years earlier than the wage given above for England :—

Average Wages paid to Coal Miners.

—	Underground per day	Above ground per day	Average annual earnings of all classes	Average wages per ton raised	Average value of product per ton
	s. d.	*s. d.*	£ *s. d.*	*s. d.*	*s. d.*
Great Britain (Durham and Northumberland, where wages are highest)	4 4	3 5½	52 0 0		
United States . .	10 0	5 5	97 5 0	3 7	4 8½
Germany . . .	2 8	1 10	38 6 0	2 2	4 8
France . . .	3 3	2 4	43 12 0	4 0	8 8
Belgium . . .	2 6	2 1	34 19 0	3 11	6 9

For the year 1900 the average wages of English colliers are given as 33*s.* 11*d.* (34·75 marks) by the Board of Trade, while for the same year 21·40 marks —with the contributions of both employer and man for insurance 23·90 marks—is given by the 'Zeitschrift für das Berg-, Hütten-, und Salinenwesen im preussischen Staate,' 1902, as the average wage of a Prussian collier. According to the comparisons of Herr Hasbach,[1] who recognises the great local differences in wages, a hewer in the North of England and the districts where earnings are highest would receive an average daily wage of 7*s.* 6*d.*, while the best paid hewers in Germany would receive about 5·24 marks ; but to the latter must be added sixty-six pfennigs to represent the value of the arrangements for insurance. For other underground workers 6*s.* 6*d.* in England would correspond with 3·38 marks (with insurance 3·85 marks) in Germany, and for workers above ground an average of 4*s.* 3*d.* to 4*s.* 6*d.* in

[1] In Schmoller's *Jahrbuch*, vol. ii. 1903.

England is confronted with 3·75 marks, including the value of insurance, in Germany.

Coking

The value of coal for smelting iron depends upon its coking qualities, upon the strength of the coke produced, its freedom from sulphur, and the percentage of ash remaining after combustion. Coking involves some loss of calorific power and volatile products; but the latter, namely, tar, gas liquor, from which ammonia products may be obtained, and coal-gas, containing benzene and its homologues in vapour, and from which cyanogen and sulphur may also be extracted, are now recoverable. Of these by-products ammonium sulphate, which is required for a number of useful purposes, for instance, as a fertiliser and for refrigeration and electro-plating, is the most valuable. The total value of the by-products may stand at about a quarter to a third of the value of the coke. Some by-product ovens were in operation in Durham as early as 1886, but their use is much less common in this country than in Germany.

Between 1885 and 1895 the number of coke ovens in the Mining Board District of Dortmund, Germany, advanced from 6,404 to 8,063; and of the total increase of 1,659 as many as 1,558 were by-product ovens, the number of which advanced from 306 to 1,864 in the ten years in question.[1] Since 1895 the number has grown largely, and in 1900 more than 40 per cent. of the total quantity of coke manufactured in Germany was produced on the by-

[1] Foreign Office Report, 1898, on the Coal Industry of Rhenish Westphalia.

product system.[1] A thousand tons of coal used in Otto Hoffmann ovens will yield on an average 750 tons of coke, thirty-five tons of tar, and about ten tons of sulphate of ammonia. The cost of dealing with a ton of coal by this system is greater than the cost under the old system, but the additional cost is more than counterbalanced by the value of the substances recovered. The 750 tons of coke would be worth, roughly, about 560*l.*, while the ten tons of sulphate of ammonia might sell for about 125*l.* As a result of the employment of the by-product method the importation of ammonia into Germany fell between 1880 and the beginning of the twentieth century from 80,000 tons to 30,000 tons. Most of the by-product coking ovens used in the German Empire are built according to the system of Dr. Otto Hoffmann; of the 1,864 by-product ovens referred to above, as many as 1,262 were of this type. The delegates of the British Iron Trade Association who visited Germany in 1896 noticed the large use made of the by-product system, but they declined to consider the question whether the coke so produced was of an inferior quality. In England, however, numerous authorities hold that by-product coke is not so good a fuel for blast furnaces as the old beehive coke. The coal is coked at a higher temperature in the beehive ovens than in by-product ovens, and is said to be more resistant to the 'solvent action of carbon dioxide' in the furnace. Whether by-product coke is satisfactory or not seems to depend in some degree on the kind of coal used.

[1] Brügmann's Paper to the Iron and Steel Institute at Dusseldorf, 1902.

By a Foreign Office Report of 1902 (Annual Series 2846) we were informed that German by-product coke made from British coal was competing successfully with British coke in Baltic ports. Our Consul at Marseilles has also reported that German coke is finding a market in the South of France.[1] The cause assigned for this competition in the face of the admitted excellence of Durham coke is the great saving effected in Germany by the extensive adoption of the by-product system; but the general trend of trade cannot be deduced from a few picked transactions the peculiar conditions of which are unknown. However, the German exports of coke have increased greatly: they advanced from 349,000 metric tons in 1880 to 634,000 in 1885 and 2,130,000 tons in 1899. Yet our exports of coke and cinders have not fallen off recently, as witness the figures below:—

	Thousand tons
1892	609
1893	603
1894	588
1895	700
1896	677
1897	978
1898	770
1899	867
1900	985
1901	808

Again, in connection with German exports of coke, the premiums on export paid by the Coke Syndicate must not be forgotten. In 1897 this association paid away 850,000*l.* as bounties on export; and in some cases as a result coke has actually been sold abroad at less than half the price in the home market.

[1] Foreign Office Reports, Annual Series 2855.

Even less use is made of by-product ovens in the United States than in the United Kingdom. In the latter country in 1898 some 1·25 million long tons of coal were reduced by the by-product method, while ten times as much passed through the beehive oven. In the former country, however, as late as 1900, while 1·55 million short tons were coked to yield by-products, some 30·58 million short tons—nearly twenty times the former amount—were reduced in the older fashion. However, in the United States, according to Mr. Schniewind, 'the long existing aversion against the use of "by-product coke" in blast furnaces and foundries has been dispelled.'[1] This statement receives some confirmation from the latest figures. In 1900 the coking ovens in operation or in course of erection in the United States were:—

(*a*) By-product:	
Otto Hoffmann system	1,626
Semet-Solway system	495
Newton Chambers system	60
	2,181
(*b*) Beehive ovens	62,107
	64,288 ovens

By 1901 the number of by-product ovens had increased to 3,293; in 1899 it had been only 1,020. Even by the old system America had been able to supply its needs with very cheap coke, partly on account of the cheapness of its coal.[2] The number of ovens of all kinds increased from 12,372 in 1880

[1] *Mineral Industry Annual* (founded by Rothwell), 1901, p. 185. On the use of by-product ovens see also the report of the Geological Survey of the United States.

[2] Bell's *Iron Trade of United Kingdom &c.* p. 69; Sixteenth Annual Report of the United States Geological Survey.

to 37,158 in 1890 and 61,386 in 1901. That the economies of the by-product system are by no means inconsiderable, provided that no great fall take place in the value of the coke thereby produced, is evident from the following figures as to the quantity and value of the by-products recovered in the coking process in America in 1901:—

	Quantity	Value
		dollars
Tar (gallons) . . .	12,695,190	320,476
Sulphate of ammonia (lb.)	12,927,627	344,320
Ammonia liquor (gallons)	2,537,510	365,080
Total . . .	—	1,029,876

Note.—Estimates of coal stores in the earth are more or less guess work, but, since interest was excited in the question by the works of Hull and Jevons, numerous calculations of the available supplies in this country have been made. Between 1866 and 1871 a Royal Commission investigated the matter. Dr. Hull, in his book of 1897, sums up on the evidence furnished up to that date, and concludes that our accessible supplies are probably in excess of 81,000 million tons and that of these nearly 60,000 million tons will be found in the visible coal fields and areas which are only partially concealed. The results of similar inquiries made in Germany were published in 1893 in a short treatise by Nasse: a *résumé* of this work will be found as an appendix to Dr. Hull's book. According to Nasse there is probably 109,000 million tons of coal in Germany within 3,333 feet of the surface, and therefore procurable. In France there are supposed to be from 17,000 to 19,000 million tons of accessible coal. The United Kingdom, we observe, could maintain the present output of coal for another 300 or 400 years.

CHAPTER III

IRON AND STEEL INDUSTRIES

In this country the iron and steel manufacture is carried on chiefly in the following places: Cleveland, Durham and Northumberland, West of Scotland, Cumberland, South Wales, South Yorkshire, Derby and Nottingham, Staffordshire, Worcestershire, and Shropshire. The leading place is the North-east. Its total output in 1899 was 3,251,396 English tons of pig-iron, of which 2,211,222 was credited to North Yorkshire, wherein lies the famous Cleveland district, and the remainder to Durham and Northumberland. In the same year 1,170,830 tons were produced in Scotland and 996,000 tons in South Wales and Monmouthshire. In the Midlands the industry is less important to-day relatively than it was formerly. Figures for the production of pig-iron, the basis of steel-making, and the manufacture of hardware, in the chief countries of the world, are stated below. These figures are derived from the estimates of experts or the returns made voluntarily by manufacturers; but their accuracy is no doubt sufficient to give the general idea which we desire to convey. When different periods are being compared in the same place the figures, being derived from the

same source, yield ratios which probably correspond closely with the facts.

The world's production of pig-iron in 1900 has been estimated at 41,000,000 English tons, and of this 77 per cent. has been attributed to the United States, Great Britain, and Germany. The various countries produced the quantities tabulated below (,000's omitted) :—

United States	13,789'
United Kingdom	8,960'
Germany and Luxemburg	8,521' [1]
Russia	2,896'
France	2,699'
Belgium	1,019'
Austria	1,000'
Hungary	452'
Sweden	527'
Spain	294'
Canada	86'
Bosnia	39'
Italy	24'
Japan	21'

Succinctly stated the relative positions of the British iron and steel industries have been as follows :—

Annual Average Output of Pig-iron in English tons.

—	1876-80		1886-90		1896-1900	
	Million tons	Per cent. of world's output	Million tons	Per cent. of world's output	Million tons	Per cent. of world's output
Great Britain	6·66	45·0	7·76	32·8	8·89	25·0
Germany	2·14	14·5	4·13	17·5	7·31	20·5
United States	2·20	14·9	7·08	29·9	11·49	32·3
The World	14·81	100·0	23·64	100·0	35·59	100·0

[1] For purposes of trade comparison, Luxemburg is taken with the German Empire, since, though an independent Duchy, it is a part of the Imperial Zollverein.

Annual Average Output of Steel in English tons.

—	1876–80		1886–90		1896–1900	
	Million tons	Per cent. of world's output	Million tons	Per cent. of world's output	Million tons	Per cent. of world's output
Great Britain	1·02	33·33	3·27	32·60	4·66	20·04
Germany .	·51	16·67	1·79	17·85	5·52	23·74
United States	·81	26·47	3·29	32·80	8·45	36·34
The World .	3·06	100·0	10·03	100·0	23·25	100·0

It is noticeable that, while our percentage of the world's output of steel is less than our percentage of the world's output of iron, Germany produces a greater proportion of the world's steel than of its iron. This difference is explained by the foreign trade in pig-iron. England has exported of late years over 1,000,000 tons more pig-iron than she has imported, while Germany has habitually received an excess of imports of about three times that amount.

Contrast with the table given above the quantities of iron produced in the chief countries in 1854 :—

Great Britain .	3·00 million tons
France . .	·75 " "
United States .	1·75 " "
Germany .	·40 " "

France has been omitted from the tables above relating to recent years, as her advance in respect of the iron and steel industries is much less remarkable than that of Germany or the United States. The output of pig-iron from French furnaces was no more than 2·14 million English tons in 1901, that is, less than a quarter of the English production and a little more than a seventh of the production in the

United States.[1] To Russia, whose output in 190c was about 2,570,000 English tons, we shall refer at the end of this chapter.

If the figures for the United States and Germany, as compared with those for the United Kingdom, need cause no serious apprehension, at least they call for some examination of the relative efficiencies and advantages in respect of the iron and steel industries of these three countries. To such an examination we shall now direct our attention, taking first the costs of assembling materials.

In respect of natural advantages it cannot be said that any one of the countries, Great Britain, Germany, and the United States, far surpasses the others. In England coal and ore lie in many places

[1] The following figures for France might be given here:—

1888	1,688,000 metric tons.
1898	2,525,000 „ „

The furnaces in blast increased in the same period from 106 to 111.

—	Steel 1888	Steel 1898	Increase
	metric tons	metric tons	
Bessemer . . .	403,300	883,600	119 per cent.
Open-hearth . .	188,400	550,100	192 „ „
	591,700	1,433,700	142 „ „

—	Bessemer 1888	Bessemer 1898	Open-hearth 1888	Open-hearth 1898
Acid . .	219,800	245,600	154,000	355,000
Basic . .	183,500	638,000	34,400	195,100
	403,300	883,600	188,400	550,100

in close proximity, and for the places on the coast Spanish ores from Bilbao and the recently discovered rich magnetic ore deposits in Swedish Lapland are easily procured. Germany possesses a vast store of wealth in the 'minette' ores of Luxemburg and Lorraine now that their conversion into steel has been rendered economical by improvements in the 'basic' process; and material is furnished for a coke almost equal in quality to that of Durham by the Westphalian coal fields, upon which the chief iron industry of Germany is placed. No part of the German industry, however, is so well situated for receiving imported material as much of the English industry, although the Dortmund district can now be served from the sea by the Ems-Dortmund Canal, which was opened in 1899. In the United States, again, ore and coal lie close together in Alabama and Tennessee, where, however, the iron and steel industries have not assumed considerable proportions; and the industry of Pennsylvania, where most of the American furnaces are to be found, in spite of the remoteness of the locality from the Lake Superior ore deposits, can utilise the Great Lakes for the transportation of ores over most of the distance that must be traversed by them. The Pennsylvanian industry, moreover, is placed hard by the coal field of Connellsville and large supplies of natural gas.

Let us now consider in closer detail the costs of assembling materials in the three countries. In 1876 Sir Lowthian Bell reported that the cost of assemblage of material for a ton of pig was about 1*l*. 15*s*. 3*d*. at Pittsburg, and 9*s*. 6*d*. in Alabama, and that the former figure was much above the corre-

sponding cost in any district of Great Britain. At that time only a little over a million tons of ore were obtained yearly from the Lake Superior deposits, and it was thought by some that the ores of the highest grade might soon be exhausted. In 1890 Sir Lowthian Bell again examined the question of the comparative costs of production in the United Kingdom and the United States, and in contrasting Pittsburg and West Cumberland, in respect of the cost of assembling materials, arrived at these results for a ton of pig[1]:—

	Pittsburg		West Cumberland	
	s.	d.	s.	d.
Ore	18	2	2	2
Coke	5	6	7	7¾
Limestone	0	10	0	6
	1 4	6	10	3

Lastly Dr. Bone has made the following calculations, using for his estimates of American costs the

[1] In this comparison for England a case is selected in which home ores only are used, but to-day we import nearly one-third of the ore consumed in our furnaces. At the time when this calculation was made our importations of ore were relatively much less.

At the same time Sir Lowthian Bell made the following estimates as to the costs of material and labour:—

	Pittsburg			West Cumberland		
	£	s.	d.	£	s.	d.
Ore	0	11	7¾	0	14	10
Coke	0	8	2	0	9	4¼
Limestone	0	0	8¼	0	0	11¼
	1	0	6	1	5	2
Labour	0	5	9	0	2	9
Other charges	0	8	0	0	2	0½
Total cost of production, including costs of material, carriage, and manufacture	2	13	9	2	0	3¼

report of the recent commission to the United States of the British Iron Trade Association[1] :—

(*a*) Estimated cost of assembling materials for a ton of iron at Pittsburg for furnaces using Lake ores.

	1901 s.	d.		Lowest s.	d.
1·8 ton Lake ore at 11*s*. 6*d*.	20	8½	at 6*s*. 3*d*.	11	3
0·9 ton Connellsville coke at 3*s*. 1*d*.	2	9	at 2*s*. 1*d*.	1	10½
0·4 ton limestone at 10*d*.	0	4	at 10*d*.	0	4
Totals	23	9½		13	5½

(*b*) Estimated cost of assembling materials for a ton of iron at Middlesbrough for furnaces using Spanish ores.

	1901 s.	d.		Lowest s.	d.
2·2 tons ore at 6*s*.	13	2½	at 4*s*. 6*d*.	9	10½
1·0 ton Durham coke at 2*s*.	2	0	at 2*s*.	2	0
0·4 ton limestone at 3*s*.	1	2½	at 3*s*.	1	2½
Totals	16	5		13	1

Thus we have the cost of assemblage in three periods as 1*l*. 15*s*. 3*d*., 1*l*. 4*s*. 6*d*., and 1*l*. 3*s*. 9½*d*. (lowest 13*s*. 5½*d*.) at Pittsburg, compared with about 10*s*. 3*d*. in West Cumberland twelve years ago, and 16*s*. 5*d*. (minimum 13*s*. 1*d*.) at Middlesbrough to-day. Moreover, as Dr. Bone points out, if home ores are used, the cost of assemblage at Cleveland can be no more than 9*s*. 3½*d*., made up as follows :—

	s.	d.
8·5 tons Cleveland ore at 1*s*. 6*d*.	5	8
1·1 ton Durham coke at 2*s*.	2	2½
0·6 ton limestone at 3*s*.	1	10
	9	3½

With regard to the position on the Continent, in 1886 Sir Lowthian Bell expressed the opinion that

[1] An account of the splendid organisation of transport between the Lake Superior ore mines and Pittsburg will be found in the last chapter.

even the German furnaces competing most successfully with this country, namely, those on or near the Rhine, could not produce foundry or ordinary pig for puddling so cheaply as Cleveland by several shillings because of the higher costs of assembling materials; but to-day the cost of assemblage is less than it used to be since the ores of Luxemburg and Lorraine have been rendered economically workable by the basic process. Belgium, according to Sir Lowthian Bell, was a little less favourably situated than South Wales in respect of cheap supplies of Spanish ore, while the cost of coke in Belgium was about the same as in England. Ten years later, when the delegates of the British Iron Trade Association visited Belgium and Germany, they estimated that the expense of bringing home ores to the furnaces was generally higher abroad than in this country, because the distances to be traversed were greater. However, since most of the works of Northern Germany procure immense quantities of ore from Luxemburg and Lorraine, the charge for transport, it was pointed out, would be reduced when the canalisation of the Moselle was complete. Dr. Bone, writing even more recently, states his opinion thus:—'It is rather difficult to form an approximate estimate in this case, because the Westphalian furnaces are fed with mixtures of various ores, and there is little available information as to the cost of getting the fuel to the furnaces. Taking, however, a typical ore charge as composed of about equal proportions of Spanish hæmatite, Nassau ore, and Lorraine minette ores, the cost of assembling ores per ton of iron would be about 14*s.* 10*d.*; and if we

allow 2*s.* for assembling the ton of coke, and 0·5 ton of limestone required, the total cost would amount to about 16*s.* 10*d.*' The conclusions to which we are apparently driven by the available evidence are partially corroborated by a recent writer in 'Stahl und Eisen,'[1] who says that Cleveland is so advantageously placed that the cost of assembling raw materials there is less than in any spot in Germany.

The prices at which iron and steel can be produced in Great Britain the United States, and Germany will now be considered.

In the year 1867 Sir Lowthian Bell undertook a journey abroad for the purpose of ascertaining what grounds existed for the alleged severity of foreign competition. The results were published in a pamphlet entitled 'Our Foreign Competitors in the Iron Trade.' Having visited, in company with Mr. Lancaster, France, Belgium, and Westphalia, Sir Lowthian Bell stated that neither he nor his companion could believe that any justification existed for assigning to the British industry a lower place than its foreign rivals. 'We have,' he said, 'our blast heated to a point never dreamt of abroad, and we have furnaces the dimensions of which have excited the astonishment of Continental ironmasters, whose opinions' (which he quoted in his report and elsewhere) 'are in strict confirmation of the superiority now maintained. I do believe, however,' he added, 'that among the higher officers engaged in French mines and ironworks you will find more frequently than is the case with ourselves—gentlemen of con-

[1] November 1, 1900.

siderable attainments in the physical sciences.' The general condition of the Continental iron trade in those days, therefore, appears to have been correctly summed up by the 'Statist':—'Foreign competition, though it has sharpened the struggle, has not gained largely upon us.' And while England stood first in efficiency, English real wages were the highest in Europe. As an illustration of Continental rates at that time we may quote those paid at Krupp's works at Essen, where between 8,000 and 10,000 hands were employed.[1] Day workmen and helpers received only 1*s.* 2½*d.* to 1*s.* 9½*d.* a day, while the wages of smiths, puddlers, carpenters, and masons averaged only 2*l.* 8*s.* to 6*l.* 15*s.* a month. These wages were the most liberal to be found in any part of Germany. Coarse provisions, indeed, were cheaper abroad; but the cheapness of provisions alone will not account fully for the lowness of the Continental money wage which was common at the time. German frugality, however, caused the best to be made of low earnings, and in works like those at Essen the economies practised in consumption no doubt enabled a high standard of vigour to be maintained. There, for example, 1,500 of the workmen lived together in a barracks with an eating-room in common, in which food and lodging could be procured for the small sum of 10*d.* a day. The real wage of a workman at Krupp's was higher than the money wage in relation to general prices would lead one to suppose, for the advantages which the excellent organisation of the Krupps brought about must be regarded as a part of their workmen's real incomes.

[1] These works contain to-day about 25,000 men.

In the decade between the 'middle seventies' and the 'middle eighties' great alteration had been effected in the relative outputs of the countries under examination.[1] As regards pig-iron, Great Britain had added some 1,500 million kilograms to its output of 6,500 millions in the earlier period, that is, an increase of about 23 per cent.; while the German output, advancing from 2,000 millions to some 3,500 millions or more, had increased at least 75 per cent. In respect of the production of steel, on the other hand, the figures for Great Britain for the two periods were approximately 600 and 2,100 millions, compared with something over 300 millions and 1,100 millions in Germany. In both countries, therefore, the percentage of increase was much the same—roughly from 250 to 270 per cent. In the next period, say from about 1885 to 1890, the percentage of increase in the output of pig-iron was 6 per cent. in Great Britain and 26 per cent. in Germany, while the percentage of increase in the production of steel was

[1] A continuous review of the comparative state of affairs on the Continent and in England from the period of which we have already written until the present time can be drawn up from undoubted authorities. In 1880 the Iron and Steel Institute visited Germany. In 1886 Sir Lowthian Bell published an exhaustive work on *The Iron Trade of the United Kingdom compared with that of the other Chief Iron-making Nations.* In 1894 the British Iron and Steel Institute visited the Continent. Two years later the British Iron Trade Association determined to institute an inquiry into the conditions of the Continental iron and steel industries, and, the inquiry having been conducted by delegates, a report, together with an account of the delegates' proceedings, was issued shortly after their return. Even more recent information is given in two papers, the one by R. M. Daelen of Düsseldorf on *Progress in Steelworks Practice in Germany since* 1880, and the other by W. Brügmann on *The Progress and Manufacture of Pig-iron in Germany since* 1880, which were read to the Iron and Steel Institute on the occasion of its visit to the Düsseldorf Exhibition in 1902.

about 75 in the former country and 100 in the latter.

The more rapid development of Germany on the whole need not have occasioned any deep-seated disquietude. Development can naturally be more rapid where there is greater scope for development, especially if protective tariffs be resorted to. England had possessed almost a monopoly in meeting the world's requirements as to many classes of manufactures, and such a position she could not reasonably expect to retain. By persevering labour, close application, and openness to receive instruction from other countries, the people of Germany have raised their industries to a level with our own in many branches, and possibly to a position of slight superiority in some branches. Until a comparatively recent date most Continental iron, steel, and engineering industries were in a very backward condition. As an example we may mention that in 1842, when railways were first introduced into France, all the rails were imported by Thomas Brassey from the United Kingdom, though the duty exceeded the cost price. The locomotives were made in France, but by English workmen. Similarly, in 1855–57, all the bridge work and engines for the Grand Trunk Railway of Canada were made on the banks of the Mersey at works which had been established for the purpose. The gigantic foundries and engineering works of the United States had not then come into existence.

The quantity of steel produced has recently assumed year by year a larger proportion of the total output of metal; the reason is to be found

in the diminishing cost of steel, which has caused it to supplant malleable iron for numerous purposes. In 1879, for example, 88 per cent. of the tonnage of vessels built in Great Britain was of iron, but at the end of the nineteenth century 96 per cent. of the tonnage built was of steel. The fall in the price of steel was largely due to improved applications of the invention of Bessemer, made in 1856, by which the price of mild steel had been lowered almost at once by about 10*l.* a ton, and of that of the brothers Siemens, which had been made as early as 1861, but had not met with immediate success. The Siemens' invention of the open-hearth process is a complement of Bessemer's invention, since the quality of Bessemer steel is not suitable for various purposes, such, for instance, as the manufacture of ship plates.

The fall in the price of steel was also due to new inventions: of these the most important is the invention made by Thomas and Gilchrist in 1878, by which the difficulty of providing Bessemer converters with a durable basic lining was overcome. Prior to this invention the Bessemer process could not be applied to a phosphoric ore. Hence Bessemer's system could not be employed for the conversion of pigs made from most German ores; it was confined to the non-phosphoric iron obtained from pure ores such as hæmatite. Thomas and Gilchrist's invention consisted in the use of calcined dolomite for the lining of the converter, which on account of its 'basic' character combined readily with phosphoric acid.

The introduction of the basic process benefited

Germany far more than England, because almost all German ores are highly phosphoric, and German works could not procure Spanish ore so cheaply as English works. Hence no doubt the reason why in the decade closing about the middle 'eighties' the German output of steel did not advance much, if at all, on the British (whereas it did considerably in the next five years), although the German output of iron increased at a far greater rate than ours—for the 'basic' process was not invented until 1878, and a short interval preceded its general adoption where conditions were suitable.

The rapid growth of the iron and steel industries taken as a whole and the very rapid growth of the iron industry in Germany between the middle 'seventies' and the middle 'eighties' would lead one to expect that a high stage of efficiency had been attained, and certainly Sir Lowthian Bell when reporting on the subject in 1886 did speak more favourably of the state of affairs abroad than he had done previously. Sir Lowthian Bell did good service in presenting the situation as a whole; for the public mind inclines sometimes to be influenced more by particular events than by broad movements. For example, as early at 1876 a distinguished English engineer said that he had obtained from Germany for use in Holland a quantity of iron bridge work, of a workmanship as good as, or superior to, that of English houses, and much cheaper;[1] and shortly after rolled girders were imported in large quantities into the United Kingdom. This naturally caused some feeling of dismay; but the explanation of the

[1] Bell's *Iron Trade of the United Kingdom*, p. 89.

facts was, as Sir Lowthian Bell pointed out, that the extent to which rolled girders were introduced by foreign architects into their designs had caused a large demand for such metal work, with the result that excellent specialised mills were established to produce it, and that foreign work of this character became cheaper and better than English work of the same kind, and was more expeditiously executed. Ultimately, however, the demand in this country became sufficient to keep girder mills at constant work, and girder mills therefore appeared, which were at least equal in Sir Lowthian Bell's opinion to any plant of the same kind abroad. Upon examining the figures as to cost of production at one of the most recent English mills Sir Lowthian Bell found that it produced cheaper than foreign establishments.[1] The same authority also collected some interesting figures in 1879 and 1880, from which he constructed the following tables to represent the comparative economies of English and German work at that time. In each case the figure for England is to be taken as 100:—

Converters:	
Work done per man	81·17
Cost of labour in ingots	63·24
Average daily earnings	43·24
Rail Mill:	
Work done per man	100·00
Cost of labour per ton of rails	86·11
Average daily earnings	61·18

The advantage in respect of price possessed by the German finished product was about 24 per cent.;

[1] *Iron Trade of the United Kingdom*, 1886, pp. 63, 64.

but this was neutralised by the cost of carriage on all goods sent here.[1] In another part of the work from which these calculations are taken figures are given for an English and a German plate-rolling mill which would not have been put forward if they were to be regarded as exceptional. They showed a relative state of affairs as regards cost of production the reverse of that depicted above; but, as it was clearly pointed out, an explanation the same in character as that which accounted for our importation of rolled girder work could be found, namely, that the article produced was a specialty in one of the countries. The English mill possessed an advantage of 24 per cent. in price, but this would have been entirely removed had the German manufacturer been dealing as a rule with orders of the same description as those placed by British shipbuilders. As the details give some interesting information about wages they are worth quotation here. At the plate-rolling mill in the North of England seventy-two men and boys received on an average 7*s.* 9½*d.* per day, while sixty-six men and boys at a German mill received 3*s.* 6*d.* per day; but the output of the English mill was three times that of the German mill.[2]

In conclusion Sir Lowthian Bell said that he had seen no smelting works in the Old World or the New to compare with those at Middlesbrough, and that foreign visitors had made the same remark to him. He attributed British superiority to our better-fed men: a fact which he had heard

[1] *Iron Trade of the United Kingdom*, 1886, p. 94.
[2] *Ibid.* pp. 92, 93.

'generally admitted abroad.'[1] English puddlers, however, pursued the doubtful policy of doing only a fixed quantity of work per day, whereas foreign puddlers laboured uninterruptedly throughout the normal day; but English puddlers nevertheless received much higher wages than any Continental puddlers.[2] So far as British manufacturers were undersold, it was chiefly in respect of goods into the production of which much skilled labour entered, and this was consequent, not upon the greater efficiency of the foreigner, apparently, but upon his greater efficiency per unit of wages.[2] However, that in one matter Germany was leading we might infer from Sir Lowthian Bell's cautious admission. 'In Great Britain,' he wrote, 'there are to be found instances of highly educated men attached to the laboratories now so common in our larger ironworks; but I am not sure whether chemists of the higher class are not more frequently met with on the continent of Europe than in British establishments.[3]

Passing on another decade and contrasting the figures of 1898 with those of the middle 'eighties' we notice the following significant facts. In the earlier period between three and four times as much iron as steel was made in both England and Germany; in the latter period in both countries the proportion of steel to iron was considerably over one-half—in England ten-nineteenths, in Germany almost as much as five-sixths. In the former period more than twice as much iron and nearly twice as much steel had been made in England as in Germany:

[1] *Iron Trade of the United Kingdom*, 1886, pp. 101, 102.
[2] *Ibid.* p. 88. [3] *Ibid.* p. 99.

in the latter period Germany produced nearly six-sevenths as much iron as England, and more steel in the proportion of about five to four. The actual figures for 1898 were :—

	Tons of pig-iron.	Tons of steel
Great Britain	8,610,000	4,666,000
Germany[1]	7,232,988	5,780,000

By 1896 the comparative state of affairs had certainly become such as to justify the appointment of the delegation to the Continent, of which mention has already been made; yet the skilled observers who constituted this delegation observed nothing in Belgium or Germany to lead to the conclusion that the United Kingdom was falling behind. While appreciating fully the technical instruction of the German engineers, they were able to say that in most processes the United Kingdom was at least as advanced as Germany. They spoke highly of the physique of the German workmen, their sobriety, steadiness, and readiness to act on instructions, and expressed their belief that early military training had contributed in no small degree to the cultivation of industrial capabilities. Nevertheless they asserted with some confidence that any difficulty we might have to encounter in competing with Germany would not be due to the greater cost of British labour. British labour, if more highly paid, was said to be more efficient—in proportion at least. It is somewhat difficult to arrive at an estimate of the comparative levels of wages in the iron and steel industries in England and Germany on account of the different

[1] These and the preceding figures for Germany include the output of Luxemburg.

systems of arranging labour in the works in the two countries; but it would appear that English and German wages in these industries are not so greatly dissimilar as in most other industries.[1]

The most striking features both of the report and the evidence of the delegates are the references to organisation. German works were said to be neat, clean, and well-designed, while the hands were described as orderly and well-marshalled; little waste of time or materials was observable, and most points of method appeared to have been carefully thought out. In several cases parties of English delegates reported that the businesses visited by them worked smoothly and steadily like perfect pieces of mechanism; that little slovenliness was to be seen and loafing was very unusual. The cause might consist, in some degree, in the early military training of the hands. It consists also in some degree no doubt in the methodical German mind, the docility of the German workman, the regard for his comfort on the part of employers—perhaps in some cases a regard expressing itself in a way which the average British workman would resent—together with the natural thoughtfulness of the German and the excellent system of education by which it is encouraged.

Works management in Germany has certainly attained to a high stage of efficiency. Major Patchett said of one works: 'I have rarely in my life been in a works—in fact I may say never—where the administration was so perfect, where the machinery

[1] See Report of Delegates and Schmoller's *Jahrbuch*, vol. xx. p. 581, and vol. xxvii. part ii. p. 25.

was so good, and where we could teach them so little. I do not hesitate to say that anybody interested in the iron and steel trades can learn something there. The sheet mill was to me a marvel.' Of the same place Mr. Trow said: 'I never saw such a compact place; and yet, with all the men there, it was not crowded at all.' Of another works Major Patchett spoke as highly: 'The arrangement and administration to me were simply marvellous; the control seemed perfect. It seemed more like a general having a well-disciplined army. At a sign every man did his work. Every engine there was as clean as in a cotton mill.' With reference to a third works a delegate said: 'We never saw a better mill for outfit and arrangement.' Numerous small devices for perfecting processes, moreover, were noticeable. Thus we are given the following description of a first-rate German Bessemer plant: 'The first thing we got to was the Bessemer plant. We went up on to the stage and saw how they were working, and everything was done in order by a lever arrangement on the stage that they could manipulate with the hydraulic cranes. At the least sign they can lift or lower or swing, and everything is done with the utmost precision. After looking round we went over the engine-house. I went particularly to the engine-house to have a look at the engines. We found alongside of the blowing engine a mechanism whereby the man at the blower of the Bessemer furnace, who was in another building altogether, can tell the engine-man exactly what pressure of blast he wants. Assuming, to illustrate it, that he has got a pressure, say, of 15 lb. on the square inch—

it is generally about 20 lb. I think—if he, for some reason, in observing the blow deems it necessary to have an additional pressure put on, he can, by the aid of electricity, simply touch the button, and there is a record immediately to the engine-man showing exactly how many more additional pounds of pressure are required. In addition to that there is another mechanism to register the number of revolutions each blow. They can tell exactly the number of revolutions the engine goes in order to produce a blow of ten tons. Each blow requires about fourteen minutes from the time that the metal is put in until it is tapped out. The engines are put away faster and the pressure increased as directed; as soon as this is done the indicator is adjusted ready for any fresh instruction. It seemed to me, however, that the most astounding thing to us in England is that there is no exhaust steam going into the air. Water is a somewhat scarce article in this part of Germany, and consequently it pays them to keep that under control also, as they seem to do everything else. The exhaust steam is exhausted into receivers—I could not make you understand without sketches—and carried away into the condensers.' The water thus obtained is cooled and stored in reservoirs for use again as it is required. The cost of the whole process of recovering the water which is usually wasted through exhaust steam being blown into the air is said not to exceed $\frac{1}{8}d.$ per cubic metre, that is 1·308 cubic yards. German industrial leaders as a rule are alive at the present time to the importance of small details. In leading iron-works the check on waste may be noticed on every side—the scrap-heap

is probably a less serious item of expense than ours. In many respects, in addition to those already enumerated, Continental works differ from English ones. As a rule they appear to be more complete; but it does not therefore follow that cheaper results are obtained than by the more specialised English system. The engineering department on the Continent is frequently a manufacturing branch of the business, containing a full engineering-plant, foundry, machine-shop, fitting-shop, forge, smith-shops, with hammers, hydraulic presses, and overhead cranes. In German 'rolling' mills, again, the engineer is responsible for the whole of the work done, and no 'rollers' are employed.

In Germany the average annual output per furnace advanced from 11,609 tons in 1881 to 21,300 in 1891 and 24,400 in 1893. Between 1878 and 1893 the output of pig-iron per man per annum in Germany increased from 132 tons to 206 tons, that is, 56 per cent. Figures for England cannot be given, as no trustworthy ones are obtainable, but many British furnaces are producing now about three times as much as was usual twenty-five years ago. The general arrangements of the German blast-furnace plants were reported by the delegates to be modern and excellent. Of the finished iron and steel works which they visited they wrote: 'We found that the practice adopted was excellent, and in some respects apparently in advance of that with which we are acquainted in this country. The German Bessemer practice was especially admirable, and the sheet and wire mills are of the latest types and seem to work with a minimum labour cost.

This feature is perhaps one of the most prominent of Continental manufacture; and while we fully recognise the advances made in this direction in English industry we were considerably impressed with the general application of mechanical arrangements for relieving labour of its more exhausting characteristics.'[1] If, however, it is true that German Bessemer plants are, on the whole, models of finished appliances, it is equally true that our open-hearth steel industry is probably the best that exists.[2]

It must not be overlooked that when an industry is expanding rapidly it keeps more easily up to date, since the manager, with extensions in mind, is ready to consider every improvement, and the newest rivals unintentionally put pressure upon the older works to renew or alter their outfits. Nothing is so stagnating to an industry as a comparatively unvarying demand combined with natural or artificial protection. The invention of the basic process gave to the German industry an opportunity which was not neglected: to-day the mass of German steel is 'basic,' while ours is 'acid,' and good prices are now being realised for basic slag.

In making up the metal Germany exhibits an efficiency somewhat less remarkable. The report above referred to continues: 'In the manufacturing departments of the works visited the production per man does not appear so favourable as in our own industries, taking into consideration the number of men employed relatively to the average results.' Herr Hasbach,[3] after quoting this remark, states

[1] Report, p. 18. [2] *Ibid.* p. 22.
[3] Schmoller's *Jahrbuch*, 1903, part ii. p. 15.

the reason given to him by one of the delegates, which ran as follows:—'British masters have as a rule worked from the ranks up; they therefore know the nature of each task and what can be expected of their hands. In Germany the industry has been imported by educated men, well versed in science, but lacking in this practical knowledge, who are consequently incapable of using their workmen in the most economical way.' This may be a true cause, but the English, on the other hand, err in not setting sufficient store by scientific attainments. A German director remarked to a party of delegates visiting the works under his charge: 'We can compete and make profits because of the scientific basis of our manufacture and the technical education of our workpeople . . . every one of our foremen and managers has had a two years' special education at the cost of the firm—a technical and scientific education.'[1] It would take us too far from the immediate purpose of our inquiry to enter into a discussion of the conditions under which technical education is made available for the hands employed in the works of Belgium and Germany, but we must not neglect to mention that this was spoken of as one of the chief causes of the success of those countries, and especially of Germany, in producing iron and steel. Special attention appears to be given to the technical instruction of the boys and young men who are coming forward as managers, foremen, and responsible hands. The German workman is naturally intelligent, though slow, and his intelligence is being trained; thus the greater

[1] Report, p. 49.

briskness of the Anglo-Saxon is being largely counterbalanced.

In both Belgium and Germany efforts are made to render the workmen as comfortable as possible. Many firms either build suitable dwellings themselves or grant loans to their hands for the purpose. In the latter case greater stability in the staff of the business is assured; but stability so secured may not be all advantage from the workman's point of view.

In some cases the industry is still carried on in conjunction with agriculture; for instance, in the Siegerland, where the latest style of large works and primitive appliances are to be found side by side. There some furnaces will yield amounts not exceeding 12 to 17 tons each per day. Compare this with the 510 tons obtained from one of the furnaces in the possession of the Deutscher Kaiser Company. When times are bad the furnaces can be damped down without the hands, who thereupon merely turn to agriculture, being driven from the district.[1] In old days in the Siegerland, when charcoal was used, furnaces were owned, not by individuals, but jointly, and each proprietor had a right to dispose of the whole plant for a certain number of working days each year to smelt iron from materials collected by himself.

The arrangements of German works are to a large extent to-day modelled on those of America, but the Germans have nevertheless made some considerable independent advance, for which opportunity

[1] Paper by W. Brügmann to the Iron and Steel Institute at Düsseldorf in 1902, p. 20.

was provided by the expansion of the industry.[1] How great has been the improvement in the management of works may be gathered from the fact that 22,000 hands were engaged in the blast-furnace industry in 1880, whereas to-day, after the product has trebled, the number of hands is only about 35,000. A great deal of the economy effected has taken place in transport, to which special attention is now devoted. Almost all works possess aërial ropeways, which are frequently employed for the conveyance of fuel to the mouths of the furnaces. And the problem of loading and unloading, as well as that of shifting material, has been carefully thought out. In Westphalia, in several plants, American systems of unloading have been introduced for the removal of ores from vessels to the furnace yards.[2]

Another example of German regard for detail is to be found in the utilisation of furnace gas for driving purposes. This has been rendered possible by the successful efforts made to cleanse it; for the difficulties at first experienced were due not so much to the imperfections of the engines employed as to the insufficient purification of the gas.[3] That furnace gas can be satisfactorily freed from dust without the application of an excessive quantity of water is now beyond question. In spite of the recent improvements in steam engines, Mr. Brügmann thinks, therefore, that they will experience great difficulty in holding their own against gas-engines. In numerous German works gas-engines are now used to some

[1] Brügmann's paper to the Iron and Steel Institute at Düsseldorf, 1902.

[2] Dr. Bone's paper referred to on p. 81.

[3] Upon this question see *Stahl und Eisen*, vol. xxii. pp. 420-24.

extent at least, and the managers of the Hoerde and Differdingen Works are so fully satisfied with the success of their experiments that they intend to instal—if they have not actually done so by now—a cleansing plant attached to the four furnaces which will be capable of dealing with an amount of gas that would yield 20,800 horse-power per day if applied entirely to power engines.[1]

In blast-furnace practice American example has been followed here and there with some success. The Deutscher Kaiser Company, for instance, has in its possession a furnace from which 510 tons of pig-iron are procured per day, and four other furnaces yielding 415 tons per day. The first of these performances approaches American records, and a daily output of 510 tons is said to be very high indeed when it is procured, as it is in this case, from an ore containing 42 per cent. of iron.[2] The figures given by Dr. Brügmann offer additional indications of the efficiency of the German industry:—

January 1 to June 30, 1902	Production of pig-iron	Number of workmen	Output per man per year
	tons		tons
Deutscher Kaiser Co.	208,651	980	419
Hoerder Verein .	255,720	685	373

In the latter works the output per man reached only 128·4 tons in 1880–81. Compare these figures

[1] Dr. Bone's article in the *Journal of the Society of Chemical Industries*, February 28, 1903. An account of the progress made in France in utilising blast furnace gas will be found in a paper in the *Bulletin de la Société de l'Industrie Minérale*, vol. i. series 4, p. 605 *et seq.*

[2] *Ibid.* We are indebted to Dr. Bone not merely for the information given in his paper, but also for reading Chapters II. and III. in manuscript and proof.

with the following, relating to the Duquesne Works of the Carnegie Steel Company.

Production of pig iron per ann. tons	Number of workmen	Output per man per year tons
620,000	477	1,300

The explanation of such an extraordinary difference lies in the nature of the ores used, American labour-saving methods, and the pursuit to the last extremity of the policy of fierce blasting. Moreover throughout America the average output per man per year was only 354 tons. The attainment of the highest output per man, however, does not imply by any means production at the lowest cost. It might pay better to economise more on fixed capital and add to the working staff; or, again, to pay somewhat lower wages to larger numbers of men than exceptionally high wages to a few.

It would appear that in Germany the expenses of producing and delivering in certain markets is at least sufficiently low to enable German iron and steel to undersell ours occasionally, and sometimes at a profit. But the loss of orders by English firms now and then—the particular goods required, the time allowed for delivery, the state of foreign exchange at the moment, and other special circumstances being taken into consideration—proves nothing as to comparative real costs of production. It is true that much German steel has recently been shipped to England, but it must be borne in mind that in 1901 the German industry was compelled to 'ease itself' by exporting at low prices, and that it was encouraged to do so by the concession in 1893 of preferential rates on the railways for carriage from the iron

districts to the ports of the Baltic and North Sea, with the result that an export of 2,347,000 metric tons of iron and iron goods was attained in 1901, instead of the 1,500,000 metric tons, approximately, of the two previous years.

Let us now consider the situation in the United States. In 1901 the United States turned out 36 per cent. of the world's pig-iron, and in 1899 40 per cent. of the world's steel; the corresponding figures for Great Britain were 23 per cent. and 19 per cent. respectively. Mr. Edward Atkinson's prediction, exaggerated as it seemed at the time, that in 1900 the United States would produce 15,000,000 tons of iron and steel has been, in effect, realised. Although the output of pig-iron was 13,789,000 English tons only in 1900, it rose to 15,878,000 tons in 1901. Of the former 10,000,000 tons were converted into steel, and of the latter 13,400,000 tons. There seems no reason why Mr. Atkinson's further prediction that the United States will produce 25,000,000 tons of iron and steel in 1910 should not be fulfilled also.

In 1840 the United States produced 287,903 tons of cast iron from 804 furnaces, almost all of which used charcoal. The centre of the iron industry then lay east of the Alleghanies, though Pittsburg contained nine rolling mills and eighteen foundries and machine shops; but the industry was to be found in some form in a great number of places throughout occupied territory. Early in the 'eighties' the Southern States entered into competition with the North. In Alabama and Tennessee ores, coal, and limestone were found together, and pig-iron began

to be produced at a cost never before reached in the United States. However, Southern ores, being phosphoric, were not suitable for conversion into steel by the acid process, and when the basic process became economically workable the South had been left behind by the development in the North of organisation and specialisation both in production and transport.[1] Both these industries, that of Pennsylvania as well as that of Alabama, suffer, as regards the possibility of developing a foreign market, from their position far inland. Pittsburg itself is 500 miles from New York. Only two American plants are on tidal water; to these ore is conveyed from Cuba and Canada, and coal must be brought a distance of 200 miles. The industry in Nova Scotia, which has been established since 1849, and is now showing unmistakable signs of a vigour which may lead to a great future, is the most favourably situated of all the plants in the North American continent in respect of export to European markets.

By the early 'seventies' the growth of the iron and steel industry in the United States had excited notice in this country. In 1874 Mr. Harris Gastrell reported upon it, and certainly did not make the mistake of underestimating American efficiency. Sir Lowthian Bell, however, took a more cheerful view of the situation. Writing to Lord Brassey in reference to Mr. Harris Gastrell's mention of 5·3 tons of steel being made in the United States at one blow, and to his report generally, Sir Lowthian Bell expressed

[1] On all the above see an interesting paper by Professor James Douglas in the *Journal of the Society of Arts* for November 26, 1897.

himself as follows:—'This week I saw in an English steel works a heat of 7·6 tons. I have, I think, in some of my reports admitted that up to 1876 the American steel makers, having laid down their Bessemer works with the light of our experience, were perhaps in advance of the older works in Great Britain. I do not remember a single works in the United States where the pig-iron, direct from the blast furnace, is taken to the converter in the fluid state. In Great Britain this is now considered indispensable to proper economy. In an iron rail mill the cost of labour could bear no comparison with ours in point of economy owing to the extravagant rates paid to puddlers. The other branches were also highly paid, but not to the same extent. In 1874 I estimated the difference to be one half higher than our own. Since that time puddlers' wages have been greatly reduced in the United States. The high cost of wages on a ton of rails, viz. $23.05 per ton, confirms me in an opinion formerly expressed that on the iron-rail mills of the United States there is not the slightest proof of any superiority. Indeed, I should say, in point of general efficiency and economy, we were far in advance. Iron rails with pig-iron at 40*s.* would scarcely bring more than 5*l.* 10*s.* here at present, leaving only 3*l.* 10*s.* for manufacturing. This includes coal, stoves, &c., whereas Mr. Gastrell mentions nearly 4*l.* 10*s.* for labour alone.' Referring to blast furnaces, Sir Lowthian Bell continued:—'I have looked over various memoranda, and I consider in point of arrangement no nation in the world can excel the best constructed works at Middlesbrough.' In his

book of a few years later (1886) the same authority mentioned that while some furnaces in America were driven at a speed greater than that attained in any other country some 50,000 tons of malleable iron were made annually in the 'prehistoric' open hearth, and 750,000 tons of pig-iron were still smelted with charcoal.[1] Writing again in 1890[2] Sir Lowthian Bell gave the average costs of producing pig-iron as 2*l.* 13*s.* 9*d.* at Pittsburg and 2*l.* 0*s.* 3¼*d.* in West Cumberland. The total cost fell in the United States between 1889 and 1898 in the ratio of 100 to 63·4, Mr. Kirchhoff of the 'Iron Age' has declared; but he declared also, after visiting some English works, that at Cleveland, under favourable conditions, pig-iron could be made at 30*s.* a ton, 'as indeed,' Mr. Jeans adds, 'I am correctly informed it has been in the not very remote past.'[3] However, this cost of 30*s.* can only be exceptional, and therefore it is of little practical importance.

As regards the present cost of production in the United States, the most contradictory reports have been set afloat. It was recently stated that pig-iron could be made at Pittsburg at about 32*s.* 5½*d.* a ton, and some 20*s.* cheaper than in the North of England; but Mr. Jeans disputes the correctness of this assertion as representing the normal state of affairs, and calculates that pigs cost on an average in the former place 45*s.* a ton, which is more than the average cost at a favourably situated district in England. The United States Industrial

[1] P. 125 of Sir Lowthian Bell's *Iron Trade of the United Kingdom &c.*, 1886.

[2] *The Iron and Steel Institute in America*, special volume.

[3] *Report of Iron Trade Association Commission*, p. 323.

Commission placed the cost of production in 1898 at 39*s*. and the selling price at 40*s*. to 42*s*. per ton. For 1900 the same Commission reckoned the cost price as 61*s*. 6*d*. Some years ago it was predicted that Alabama and Tennessee would soon turn out regularly a six-dollar pig; that expectation, however, has not yet approached fulfilment; and it is said that the materials obtainable in the South are not of the best quality, and require much humouring. Schemes have been put forward for connecting the Southern industry by a continuous waterway with Mobile. This would render the cost of carriage to the coast much less than the cost of carriage from Pittsburg to the nearest port, which is now over 8*s*.; but there would remain, as regards European markets, the second handling and the cost of transportation across the Atlantic.

The most characteristic difference between blast-furnace practice in England and that in America during recent years has been the greater relative rapidity with which American furnaces are worked. A weekly output of about 1,000 tons, or a little more, per furnace is considered good in England; but some furnaces in America can turn out more than 4,000 tons a week. Certain furnaces have produced about 800 tons in twenty-four hours. The American ironmaster wears out his furnaces much faster than the English ironmaster—in America furnaces require lining about every five years—and argues that the saving of interest on his fixed capital account justifies him in doing so. However, English experts are by no means convinced that larger economies can be effected by this practice. An English furnace will yield a greater quantity of

pig-iron in the course of its life than an American furnace; the English furnace, in addition, is much the cheaper, and lasts about three times as long as the American one without relining. Moreover, the nature and quantity of the supply can be accommodated to demand more nicely when a given output is obtained from, say, six furnaces than when it is obtained from two or three which work faster and are perhaps bigger. As regards the size of furnaces, according to Mr. Axel Sahlin's supplementary report to the Iron Trade Association, which was read at a conference held in London on March 31, 1903, after another visit by him to the United States early in that year, there is now some reaction against the large furnace in the United States. 'It has been found,' Mr. Sahlin says, 'that the expense incurred whenever one of these large furnaces, built a few years ago, gets out of order is very great, and that the effect of a large percentage of incidentally high sulphur iron on the average metal from the mixer is apt to cause variations in the steel works. The latest conclusion is that it is better, though somewhat more expensive, to run two 300-ton blast furnaces than one of 600 tons capacity. The capacity of from 300 to 400 tons is at present the one most generally recommended for new furnaces.' The furnaces in America are fed as a rule by a continuous automatic process. As regards blowing power, Americans adhere to the steam engine; Europe is ahead in the employment both of gas engines and steam turbines. The cause, Mr. Sahlin believes, is not the superiority of the ordinary steam engine, but that American works, as a result of good times in the United States, are

in this respect somewhat antiquated. Summing up, Mr. Axel Sahlin writes:—'The more I learn about the relative conditions and possibilities in Great Britain and America, the more I am convinced that the better part of our (English) iron and steel industry occupies an unassailable position. Naturally, however,' he adds, 'this position cannot be maintained or be made profitable unless we take advantage of the improvements for which British engineers and chemists in the past largely have laid the foundations, but which we of late have permitted foreign countries to develop.'

No less in the production of steel than in that of iron America has advanced to a high level of efficiency. In 1901 the output of steel in English tons by the three chief producing countries was as follows:—

	Bessemer converters	Output in million tons
United States	81	8·7
United Kingdom	78	1·7
Germany	126	4·3
	Open hearth	Output in million tons
United States	403	4·7
United Kingdom	500	3·2
Germany	239	2·3

In Germany, we may notice, as illustrating the value to that country of the invention of the basic process, ninety-eight of its 126 Bessemer converters were basic, while as many as 216 of its 239 open-hearth furnaces were basic also. In America nearly all the open-hearth work is basic.

Mr. Enoch James reported at length in 1902 upon the steel-works practice in the United States for the British Iron Trade Association, and in 1903, at the London conference, he made another

communication upon the same subject. In both the Bessemer and the open-hearth systems the output per converter or per furnace and the output per man were said by him to be higher in the United States than in England. As contributing to this result Mr. James laid emphasis upon the purity of the American pig which makes conversion easy; casting in cars instead of in the old-fashioned pits, which saves the labour of raising the ingots on to the cars used for conveying them to the soaking pits, and facilitates the stripping of the moulds from the ingots; the use of molten iron in the open hearth as well as in the Bessemer process; and the economies of the Wellman electric charger, which in America is to be found at every open-hearth plant of any size. Another cause of cheap working in the open-hearth process at Pittsburg is the use made there of natural gas.

With regard to methods of facilitating continuous working and securing uniformity in the quality of steel produced, neither country, we should judge, can be placed in advance of the other. One of these methods consists in the use of a mixer, that is a large receptacle in which the pig tapped from several furnaces is kept molten, and from which the charges are taken to the converter. Inasmuch as charges from different furnaces are united in the mixer, impurities such as sulphur and silicon are averaged. American mixers in the best works have a capacity of from 200 to 300 tons. In both countries uniform quality is also being secured in open-hearth steel by the use to a slight extent of the tilting furnace and the Talbot furnace which have recently been introduced. These are furnaces which work con-

tinuously, and which are periodically emptied of a part of their contents only. The remainder mixes with the new charge, and thereby an average quality of steel tends to be maintained. In the open-hearth practice direct metal working—that is, working with molten charges—effects a saving of some importance, but unfortunately in England some of the best firms making open-hearth steel are not makers of pig-iron. Turning to rolling-mill practice Mr. James notices in particular the greater specialisation of plants in the United States and its attendant economies. In the production of crucible steel, however, the Americans have not shown the same advance as in other departments of the iron and steel industries, and to-day a great quantity of crucible steel is imported from Sheffield. On one aspect of the iron and steel industry as a whole we may quote here the opinion expressed by the director of a German steel plant, who was interviewed for the 'Berliner Tageblatt,' on his return from a visit to America in 1900, that the Germans would have to follow the Americans in making a more extended use of labour-saving machinery.

It is interesting to contrast with the impression created by the American industry amongst English visitors the opinion which American visitors to England form of our industry. In 1900 a correspondent of the 'Iron Age,' an American paper, visited several English works. The most striking feature of the English iron industry to-day, he declared, was 'its pessimism and lack of courage,' and, while condemning our conservatism in technical matters, he does not appear on the whole to have found any justification for self-depreciation and timidity. The 'wrecker,'

our critic pointed out, was less known in the United Kingdom than in America, and, in consequence, 'the appearance of defeat is much more marked than it really is, since much of the rubbish of the battlefield is allowed to rot in place.' In America successful works are constantly being enlarged; in Great Britain there is not the same tendency for paying businesses to make any great efforts to extend their operations. The British industry, he concluded, showed stagnation in comparison with those of Germany and America, but not absolutely. Upon this point we should argue that the American and German industries have grown fast because there was much scope for growth, and that rapid growth provides opportunities for frequent changes in method. In short, the up-to-date character of many American works is as much an effect as a cause of the expansion of the industry in America. The same writer in his article of September 13 reminded his countrymen that cheap iron was being made outside Pittsburg, and that pigs could be produced in some works at Middlesbrough for $7 a ton within a stone's throw of the ocean. Sir Lowthian Bell apparently had some grounds for his persistent scepticism as to the extent of the advantages claimed for Pittsburg. We should do well to bear in mind that visitors to America almost invariably, and rightly, try to see the best that is to be seen, and report upon that, and not upon the worst. The following facts will serve as an interesting comment upon this. In 1903 five American rail mills could produce about four-fifths of the total annual output of rails, but forty-five rail mills are enumerated by the Iron and Steel Associa-

tion.[1] Needless to say the five leading mills are the ones usually visited. However, in respect of the use of machinery the Americans now stand ahead. As to this, Mr. Ebenezer Parkes, M.P., the President of the British Iron Trade Association, remarked at the conference in London on March 31, 1903, that more pluck would be needed here in 'scrapping' antiquated machinery. In one of the most successful Bessemer shops in the United States the whole plant has been reconstructed no less than four times in the last twenty-five years.[2]

The wages paid in October 1901 at certain furnaces in America and England are given by Mr. Sahlin: they are quoted on the next page. The figures were obtained by him from the managers of different works. The rates are all for twelve hours' work, which means one shift in America and one and a half shifts in England.

The average earnings per head at the Homestead works were recently 11*s.* 3*d.* per day, while rollers and heaters made as much as 62*s.* 6*d.* per day. The following average wages paid for all labour employed were collected by Mr. Jeans[3]:—

	Average per annum £	*s.*	*d.*
Lancashire (iron and steel works)	68	0	0
Derbyshire (blast furnaces, foundries, &c.)	61	10	0
Yorkshire, W. (blast furnaces and steel works)	70	0	0
South Wales (steel works)	79	0	0
Northamptonshire (blast furnaces)	64	0	0
Cumberland (blast furnaces)	70	0	0

Taking 11*s.* 3*d.* as the average wage per day at the Homestead works, we arrive, after multiplying by

[1] *Report of the Mosely Commission*, p. 88.
[2] Report of 1902, p. 518. [3] *Ibid.* p. 55.

Comparative Blast Furnace Wages in United States and in England, October 1901.

Location of Furnace	America								England	
	Eastern Pennsylvania	Central Pennsylvania	Pittsburg (large furnace)	Shenango (small furnace)	Shenango Valley	Lake Front	Birmingham (Ala.) District	Northern Alabama	North-West Coast	Middlesbrough District
Approximate weekly make	tons 1,000	tons 1 500	tons 4,000	tons 1 750	tons 3 500	tons 1,500	tons [illegible] 200	tons [illegible]	tons 850	tons 620
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Keeper	8 2	7 8	10 11	10 5	10 5	11 5	7 3½	7 1	10 6	10 1½
First helper	6 5	6 8	8 6	8 4	8 4	9 2	6 8	5 10	8 2	6 2
Second helper	6 5	5 10	8 1	8 4	8 2	9 2	5 11	5 2½	—	—
Slagger	5 5	5 10	7 5	8 4	8 4	9 2	5 0	5 2½	8 2	6 9
Caster		—	6 0		6 3	9 2	—	—	6 1	—
Scrapper			6 0		6 3	9 2	—	4 7	6 3	—
Water boy			—	—	—		—	2 0	3 9	3 9
Stove-tender	7 1	6 0	8 11	8 4	8 9	9 2	7 3½	6 3	7 8	7 1
Filler foreman	—	—	12 6	—	8 4	—	—	—	—	—
Fillers		—	7 6	8 4	6 3	8 2	5 0	4 7	8 2	6 7
Top fillers	7 1	6 3	8 6	12 6	—	9 2	6 8	6 8	8 2	7 11½
Lime fillers	6 5			7 11	—	—		4 7	3 7	6 5½
Weigh-man	—	6 9	9 5	—	8 9		4 7	5 2½	5 4	5 3½
Hoist engineer	8 4	5 10	9 5	—	8 9	—	—		7 6	6 5½
Sweepers	—	—	—	—	—	—	4 7		3 9	4 1½
Stock unloaders	5 2½	5 10	—	9 0	6 8	6 3		4 2	5 9	7 0½
Pig lifting	Direct metal and casting machine	Casting machine	Direct metal and casting machine	0 7 ton chills	Direct metal	0 7 ton sand	6 10 sand	7 7⅓ sand	0 5 4/10 ton pig breaker	7 11½ sand
Blast engineers	8 4	9 5	11 7	10 6	10 5	12 6	9 5	8 4	7 11	7 11
Oiler	—	6 3	7 4	—	7 6	9 2	4 7	4 2	6 0	3 9
Cleaner		—	6 10	—	—	—		—	—	—
Boiler tenders	6 3	6 3	10 6	8 4	8 4	13 6	6 2	6 3	6 8	7 5
" fireman		5 10	7 7	—				—	—	5 6¾
Yard loco driver	—	8 4		—	12 6	—	—	8 4	7 9	7 4
Conductor		6 8	—	—	8 4	—	—	6 3	—	—
Fireman		5 10		—	9 2	—	—	5 2½	5 8	5 6½
Slag loco driver		8 4	8 4	—	—	9 5	—	7 3½	6 4½	7 4
" fireman		5 10	7 5	—		—	—	4 9½	3 3	5 8½
" conductor	—	6 8	—	—	—	—	—	—	—	—
Labour (per hour)	0 6½	0 5½	0 6	0 7½	0 7½	0 7½	0 4½	0 4½	0 4¾	4¾

300, at an annual average of about 168*l.*; but it is the boast of Mr. Carnegie that the wages at Homestead are exceptionally high, and it is the American policy to substitute machinery as far as possible for unskilled labour.

The real American workmen are highly efficient, and Mr. Cox, of the Associated Iron and Steel Workers of Great Britain, denied in his report for the Mosely Commission that they were rushed. But from the sum of available evidence as to the American operative it is certain that he is worked harder as a rule than the British operative. The labour cost of producing pig-iron in America, however, is higher than one would be inclined to suppose, because many of the hands employed are not very capable to begin with, and many of them are foreigners. Thus Mr. Sahlin reports that the Americans round the blast furnaces are in a decided minority. They may be found as foremen, master mechanics, blast engineers, locomotive drivers, or stove tenders, but they will not labour for eighty-four hours per week 'shovelling ore or wheeling scrap.' 'For these duties,' Mr. Sahlin continues, 'are employed in the South the negroes, and at the Northern furnaces immigrants, mostly Irish, Slavs, or Italians.' Mr. Enoch James doubts whether the operatives at American works are really more efficient than those performing the same tasks in England.[1] He is confident, however, that the American workmen are more regular in their attendance and not so much addicted to drinking habits, notwithstanding that all steel plants and rolling mills in America

[1] Mr. Enoch James' report on steel-works plant.

work longer hours than those in England. The higher posts in the iron and steel industries of America are filled in numerous instances by men born in England.

The phenomenal expansion of late years of the American iron and steel industry has been occasioned largely by the increasing demand for iron and steel in the United States. Moreover for heavy and bulky commodities the obstacle to transport presented by the Atlantic constituted a strong protective barrier. This has been raised by high tariffs—$7 a ton on pig-iron in 1870, for instance, after a duty of $9; $6·72 in 1883, and $17 a ton on steel rails after one of $28; $4 per ton on pig-iron, and $7·84 on steel rails in 1894. It would have been remarkable indeed if many orders had gone abroad under such discouragement. Meanwhile the home demand was increasing fast; a mighty continent was to be subdued to the service of man; the natural increase of population was supplemented by hosts of immigrants; and no materials to-day contribute more to economic development than iron and steel. They were required for machinery, engines, locomotives, rails, bridges, and ships; now, in addition, steel is in demand for the huge trucks employed in the transportation of heavy goods in the United States, and also for building. No country in the world utilises steel so much for building purposes as the United States. At present it is the rule in America to construct tall edifices in the form of steel cage-works standing on concrete foundations, with walls which consist of brickwork or masonry and are built in between the

steel girders, to serve as shields against the weather and not as supports. Steel being demanded on so large a scale it is not surprising that it is now produced on a scale unequalled in any spot in Europe.

The Americans as well as the Germans have to-day a pronounced belief in the value of higher education. In the United States, of those at the head of affairs and in responsible positions, the proportion of University graduates and other highly educated men is large. This is true of many businesses besides the iron and steel industries. We shall deal with the question of education in another volume, but we must not omit to refer to it here as one of the causes of American successes.

While the Russian iron and steel industries, fostered as they are by the Government and protected by high tariffs, cannot be regarded as other than artificial, their recent development calls for a brief notice here. In 1900 the Russian output of pig-iron was 2,878,000 metric tons, and of steel 1,439,710 tons. The production of pig-iron is, therefore, less than a third of that of the United Kingdom. Most of the Russian industry is in the south, where vast supplies of coal and ore lie not far apart. The southern district produces about half the total output of Russian pigs, and half of the remainder comes from the Ural. The Ural district is thoroughly Russian: there expansion is slow and speculation is almost unknown. Into the southern industry, however, Western Europeans and the spirit of Western European trade have penetrated. This district, therefore, experiences bursts of prosperity followed by periods of depression. Most of the blast furnaces

in South Russia possess their own mines, collieries, and coke ovens, but steel is, as a rule, produced in separate works. Of the fifty-five blast furnaces twenty-one are Belgian; little English capital is invested in these South Russian industries. The higher officials of the various works are usually of the nationality of the owners, but the workmen are all Russians. Of the latter, Mr. A. P. Head, who carefully examined the Russian iron industry in 1901, writes that they are 'patient and obedient, but they are less energetic and efficient than the more highly paid workmen of Western Europe—which tends to counterbalance the advantage of cheapness. They are also lacking in mechanical instinct and initiative.'[1] They used to be drunken, but the Government by taking over the manufacture and sale of spirits a few years ago managed to reduce largely the *per capita* consumption. The supply of labour for industrial purposes in Russia, and the concentration of industry, are checked by the village commune system, which operates in keeping the peasants in the place of their birth. This tie, however, is weakening through the subdivision of the land, which in other respects is an evil. Of the demands for iron and steel far the largest is that of the Government. Railway extension in the Russias and development in general should ensure the continued growth and increasing efficiency of the Russian iron and steel industries; but to-day Russia is far from entering the field of European competition.[2]

[1] *Journal of the Society of Arts*, December 19, 1902.

[2] On the above see Mr. Head's interesting paper already referred to, and the Foreign Office Report on the Mineral and Metallurgical Industries of Russia in 1901.

CHAPTER IV

THE METAL INDUSTRIES: SHIPBUILDING AND ENGINEERING, MECHANICAL AND ELECTRICAL

OUR main purpose in the first part of this chapter is to make a comparative estimate of efficiency in shipbuilding; but if the condition of any industry is dependent upon the magnitude of the businesses to which it is in a sense subsidiary, it will be desirable to introduce the discussion of our chief topic by some account of the amount of sea-transport conducted from different national bases. England being the country which leads in the business of carrying over the seas, it would be remarkable indeed if our vessels were imported: for it is apparent that the industry which subserves another is carried on at its best when it is kept in close and continuous touch with that which it subserves. The tables annexed make clear that the relative position of the British sea-carrying trade has greatly improved in the course of the last half-century:—

Growth of the carrying capacities of Mercantile Fleets in millions of Tons

(The tonnage of steamers is multiplied by 3 and added to the tonnage of sailing vessels)

—	1850	1860	1870	1880	1890	1895
Great Britain	3·46	5·64	7·95	12·51	18·89	23·04
British Possessions	·63	1·07	1·67	2·25	2·24	2·21
Germany	·51	·87	1·15	1·56	2·56	3·34
United States	1·33	2·04	1·59	1·59 (1879)	3·93[1]	4·20
France	·69	1·18	1·46	·68	2·12	2·25
Norway	·29	·56	·98	1·62	1·95	2·22

[1] Including the larger vessels used on inland waters.

In this table, based on Kiaer's figures, only vessels of '*long cours*' appear to have been admitted. A larger proportion of the shipping of the world has been included in the figures that follow. In the first five columns steamers have been reckoned at four times the capacity of sailing vessels, instead of three times the capacity, which is the ratio taken in the table above and in the last two columns of the table below.

Flag	Carrying capacity based on net tonnage (steam tonnage multiplied by 4)					Carrying capacity based on gross tonnage (steam tonnage multiplied by 3)	
	1820	1840	1860	1880	1888	1900-1*	1901-2*
British . . .	2·65	3·60	7·22	16·81	22·90	—	—
" (excluding colonial) . .	2·44	2·84	6·03	14·75	20·52	38·09	39·72
German . .	·3	·58	·85	1·83	2·74	7·06	7·83
American . .	1·3	2·78	7·96	7·70	9·62	4·91	5·51
French . . .	·45	·66	1·27	1·75	2·49	3·52	3·64
Norwegian . .	·11	·26	·85	1·69	1·94	3·21	3·22

* Sailing vessels over 50 tons net register and steamers over 100 tons net register are included – net tonnage is two-thirds of gross tonnage

It will be desirable to give side by side with these figures others to show the relation of the American tonnage engaged in the foreign trade to that engaged in the home trade (coasting, river, and lake vessels) :—

In million net tons of vessels of about five tons and over.

United States	Foreign Trade	Home Trade	Foreign Trade	Home Trade	Foreign Trade	Home Trade	Foreign Trade	Home Trade
Sailing .	1·23	2·31	1·21	1·65	·75	1·82	·49	1·90
Steam. .	·19	·96	·15	1·06	·20	1·66	·36	2·12

Such being the facts as to the sea-carrying trade, it is but natural that British predominance in shipbuilding should be even more marked. As the great cotton-spinning and cotton-manufacturing country we are the chief exporters of machinery for that industry; as the great ocean carriers other nations look first to us for the provision of their own mercantile fleets.

Production of ships (average 1886–90)

—	Steam		Sail	
	Ships	Tonnage	Ships	Tonnage
Great Britain and Ireland	580	520,717	312	122,963
France	47	17,371	614	11,182 *
Germany	42	32,433	55	16,126
United States:				
Sea-going	18	15,310		
Lake and River	345	80,167		
Total, United States	363	95,477	422	45,291

* Including fishing vessels.

With these figures compare the output of sea-going vessels of the shipbuilding industry in the same four leading countries in the last four years of the nineteenth century, according to Lloyd's statistics.

Steamers (average for 1897–1900)

	Number	Tonnage
England	615	1,249,809
America †	70	154,118
France	13·75	25,408
Germany	72·5	176,508

Sailing Vessels

	Number	Tonnage
England	9·75	8,697
America †	68	70,925
France	87	43,510
Germany	18·75	5,902

† Including the output of the yards on the Great Lakes.

These four countries together produced about 91·1 per cent. of the world's ships in 1900: 64·2 per cent. of the production fell to England, 13·1 per cent. to the United States (including the vessels used on the Great Lakes), 9·3 per cent. to Germany, and 4·5 per cent. to France. On comparing the two tables we notice that the proportion of Great Britain's output to the output of the four countries taken together was about the same in the two periods 1886–90 and 1897–1900: it was just over 78 per cent. in the first period, and just under 78 per cent. in the second period. This cannot be regarded as otherwise than highly satisfactory in view of the efforts being made by other countries and their developing industrialism, and especially in view of the fact that the traffic on the Great Lakes has been very considerably augmented, and that the whole of the increased tonnage involved is necessarily accredited to the United States or Canada.

The relative positions of the shipbuilding industry in the most advanced countries have been exhaustively investigated by the shipbuilding expert Herr Tjard Schwarz in collaboration with Professor Ernst von Halle. To their two-volumed work entitled 'Die Schiffbauindustrie in Deutschland und im Auslande '[1] we are indebted for most of the comparative estimates stated below, or for a great deal of the information upon which they are founded.

The English shipbuilding industry has only partially introduced the newest improvements. Electric and pneumatic machinery is but little employed, the systems for the carriage of material about

[1] Published in 1902.

the yards are less developed than they might be, and labour-saving machinery is not afforded that position for which its economies render it suited. On the other hand the British industry possesses differential advantages in the high position which British mechanical engineering occupies (upon which, of course, shipbuilding is in some degree dependent), in the splendid training undergone by the workmen, in the presence of subsidiary industries for the satisfaction of a wide circle of needs, in the development of standard types of vessels and the organisation of the industry, together with other businesses involved in it, for cheap production on the lines of the prevailing patterns. But in respect of the design of works, the machinery employed, the application of power other than steam, and the shifting of material, the industry of the United States stands in the first place. English shipbuilding yards are on the whole contracted, overcrowded, and, so far as they are covered, dark. American yards, on the other hand, are almost invariably spacious. The rooms in American works are lofty, and most of the working space in the shipyards is fitted with excellent systems of overhead cranes. The cause of the difference is no doubt that the Americans are making a supreme effort to build ships economically, and are therefore laying down their yards on the most approved designs and fitting them with the most recent machinery; whereas the English having hitherto attained such splendid results with simple means have tended on the whole to cling to old methods. In respect of the use of pneumatic machines and mechanical

systems of transport within the works, America stands easily first of all advanced nations.

Nevertheless the balance of advantages in production rests with the English works. In a typical British shipbuilding yard vessels are constructed at a lower real cost than in any American yard. The following passages from 'The Shipping Industry of the United States and its Relation to Foreign Commerce,' to be found in the 'Summary of Commerce and Finance,' December 1900 (Washington, 1901),[1] will throw some additional light on the causes which have already been briefly noticed above. 'The distinction between building ships and manufacturing ships has been used to bring out the reason why in building ships of any particular class we are not able to compete with the British shipyards at the present time. This raises the question whether, if shipbuilding can be reduced to a manufacturing industry, as the building of railway engines is to-day, it would not be possible to build ships as economically as is done in any other country. "I think," says Naval Constructor J. H. Linnard, "if we reflect on the lines of manufacture in which we have within recent years been successful in competition with foreigners, we will see that they have been such lines as we have in our practice standardized. The manufacturers have standardized the types of land engines which have been spoken of in this connection. They have standardized electrical machinery. Their whole production tends to a standardized arrangement of their outfit, which becomes regular in process of manufacture, and can

[1] Quoted from Schwarz and Halle.

be put forth with a complete arrangement of their shops towards a definite fixed end from the beginning. The question which arises in my mind is whether we will ever be able to build ships on that basis, whether we will ever be able to manufacture ships instead of building them." The discussion of the question at the December (1900) meeting of the Society of Naval Architects brought out the following facts. In English shipyards it has been noticed that frequently in the case of tramp steamers three or four vessels would be laid down at the same time, so that the moulds and the machinery outfit would be alike for all the ships. In contrast with this in the United States it was the rule to build a single ship or two, and where there was Government work in hand the men shifted about a good deal from one style of work to another. This point of view was presented by Mr. E. Platt Stratton, who understood that English builders figured that where three or four vessels of a kind were built at one time the cost would be about 15 per cent. less. . . . If we accept Mr. Cramp's estimate of a difference varying from 15 to 25 per cent. as measuring the greater cost of building merchant ships in the United States, it would seem that the whole question of the reduction of cost hinges on the question of the volume of demand for merchant ships on the part of the United States. If the volume of demand, hitherto restricted and under present conditions rapidly enlarging, should reach the point at which the existing shipyards of the country of first-class equipment could rely upon two or three times the amount of tonnage now turned out per annum, it would seem that no great

length of time could elapse before the difference of 15 to 25 per cent. could be overcome by progress in the economies of production. . . . There is some doubt as to the possibility of standardizing ships, at least to such an extent as we have already attained in building bridges, railway engines, and stationary engines. A modern steamship is a much more complex agency than a bridge or a locomotive engine, and while standardizing may apply much more largely than is at present the case in the production of special features, it is certain that the present practice of standardizing does not generally prevail in the manufacture of hulls and ship machinery, except as ships are built to a standard for record and to come under low rates of insurance. In answer to an inquiry by the Bureau of Statistics as to the extent to which the practice of standardizing prevails in the manufacture of hulls and ship machinery, the following answers may be taken as representative of prevalent conditions. One of the oldest shipyards on the Delaware replies: "To our minds standardizing does not prevail to any large extent, at least not in our works. Of course for certain owners we build a certain class of ships, and very often they, knowing their own wants, practically change very little from ship to ship; but we would say that standardizing does not prevail to any great extent." A New England shipyard replies that "in wood shipbuilding the practice is most pronounced, but in steel shipbuilding 'standardizing' is practically unknown, as the demand, being small and of different varieties, is not sufficient to warrant it. Standardizing, the king of cheap and rapid

methods, will come as the demand for new ships increases." '

In respect of the specialisation of businesses, the American industry, shipbuilding on the Great Lakes excepted, does not approach the position held to-day by either England or Germany. France, too, hangs behind; her iron and steel industries are not well placed in relation to her shipbuilding yards, and for materials and machinery, she is partly dependent upon foreign sources of supply. The German industry has recently made great advance. In many of its yards the appliances used are of the most recent introduction, and the trade as a whole is being brought into closer touch with the industries from which material is derived. Some attempts are also being made to reduce the variety of needs by developing a limited number of types of vessels.

With regard to labour as a whole, England would appear to be easily first, according to the evidence of Schwarz and Halle. For the education of those who direct in the business of shipbuilding there is no training ground like the United Kingdom, largely because experience may be gathered here as nowhere else in the world. For this experience the best system of education conceivable is no perfect substitute, though by a well-devised system of education its value may be greatly augmented.[1] The English shipbuilder possesses an incomparable mastery of practical detail. Hence two at least of the leading American shipbuilding yards employ English experts, and

[1] Our chief shipbuilding schools are those at Greenwich (Naval School) and Glasgow.

young American shipbuilders visit England in considerable numbers to improve their knowledge.

The finest and best-trained workmen are also to be found in England; but it is pointed out at the same time in the work from which we are quoting that the attainment of the highest degree of development in British yards is being prevented by the prevailing notion, on the part of the men chiefly, that the interests of masters and men respectively are conflicting. In America, on the contrary, while labour is not so splendidly efficient, employers experience no opposition in their attempts to make further advance, both technically and in organisation; labour-saving machinery and analogous appliances are being given a constantly extended application; and the industry in consequence is being stamped with a character which may shortly bring it into keen competition with the English industry. The French workmen, among whom the South European type prevails, are alleged to be inferior to both German workmen and Anglo-Saxons. Shipbuilders in France seem on the whole to look more to subsidies than to economical production, and to concern themselves less with enlarging the scale of work and reducing costs than with conducting experiments upon a number of theoretical points. Therefore, in one respect at least, namely, in the spirit of inquiry and experiment pervading it, the French industry may be placed in the forefront. As to the training of employers and those requiring technical knowledge, Germany stands high. The German training is better theoretically than the American, and better practically than the French,

and English standards in these respects are said to be fully reached. However, the English workman, and in some respects the American workman, must certainly be placed before the German workman, but our authorities suggest that German labour legislation may secure for the German industry a more peaceful future than either Americans or Englishmen can look forward to with any degree of confidence. Upon this point, however, we should be inclined to argue that, taken all round, the lines upon which our solutions of labour problems lie are laid down as wisely at least, from the standpoint of the future especially, as those of any other country. English wages are high—not so high, however, as American—but higher still in proportion is the skill of the English shipbuilding artisans. And although England certainly does not suffer from a heavy labour cost, the normal weekly hours of work are fifty-three in England, fifty-four in America, and sixty in Germany, while in France they oscillate according to needs from forty-five to sixty. Moreover a summer holiday of a fortnight is usual in England. One of three weeks is allowed in American State yards.

The English business of sea-transport being so immense, it is not surprising that a lower cost of production is reached here than abroad. The cost of production in Germany, however, has compared not so unfavourably with ours as regards certain classes of vessels, and the United States is said to have reduced the difference between its supply price of vessels for the world's market and Great Britain's from about 27½ per cent. in 1892–4 to under 10 per cent. in 1900. Upon the Lakes, moreover, vessels

are said to be constructed at costs no greater than those at which tramp steamers are built in England, in spite of the high American wages—perhaps in some respects in consequence of them. The severity of protection in France, combined with other causes, has rendered her cost of production prohibitively high for those who can purchase freely in other markets. We may notice in conclusion that the American shipbuilding industry of the first half of the century, such as it was, declined in consequence, in some degree, of the substitution of iron and steel for wood in shipbuilding, which was hastened by the stimulus given to the construction of fast steamers by the opening of the Suez Canal in 1869. In those days iron and steel could be procured cheaper by British ship-yards than by American ones. Moreover, the American Navigation Acts, in so far as their object was the encouragement of American shipbuilding, reacted very detrimentally on the American sea-carrying trade when British ships were being built much cheaper than American ones;[1] and the decline in the carrying trade meant again a decline in shipbuilding. Here we have undoubtedly some of the chief causes which explain the position of American shipbuilding to-day; but we must remember that other causes were equally at work. England was better situated for prosecuting the trade of sea-transport than America, and the advantages of her position were heightened by the opening of the Suez Canal. Moreover, payment had to be made for the large export of American food

[1] See Mr. D. A. Wells' interesting work on the American mercantile marine.

and raw material; and as high duties were imposed on all manufactures by the United States, special encouragement was afforded to the system of settling debts owing to America by the performance of shipping services for the Americans.

The figures below will indicate approximately our relative position in respect of the trade in machinery :—

Average annual imports and exports in million pounds sterling.

Great Britain.

Imports	£	Exports, 1896–1900	£
1897–1900	2·8	Steam engines :—	
		Locomotives	1·3
		Agricultural and other descriptions	2·3
		Other sorts :—	
		Agricultural	·8
		Textiles, and other descriptions	12·6
		Total	17·0
		1886–1890	
		Steam engines :—	
		Locomotives	1·2
		Agricultural and other descriptions	2·3
		Other sorts :—	
		Agricultural	·55
		Textiles, and other descriptions	8·5
		Total	12·6

United States.

Imports	£	Exports, 1896–1900	£
1897–1900	0·4	Steam engines and parts of :—	
		Locomotives	·8
		Fire, stationary, boilers and parts of engines	·8

Average annual imports and exports in million pounds sterling.

United States (continued).

Imports	Exports	£
	Agricultural implements[1] .	1·9
	Other machinery:—	
	Cash registers, laundry machinery, metal working, electrical, printing presses and parts of, pumps and pumping, sewing machines and parts of, shoe machinery, typewriting machines and parts of, all other .	6·5
	Total	9·5
	1886–1890	
	Machinery, all kinds . .	2·6

Germany, France, and Belgium.

		£			£
Germany	1895–99 . .	2·2	Machinery, kinds not specified	1895–99 . .	6·2
	1886–90 . .	1·4		1886–90 . .	2·8
France	1895–99 . .	2·95	"	1895–99 . .	1·94
	1886–90 . .	1·7		1889–90 . .	1·8
Belgium	1895–99 . .	1·03	1895–99	Machinery: locomotives and railway rolling stock . .	1·7
	1889–90 . .	0·54		Other machinery . .	1·5
			1886 90	Machinery . . .	1·6

From this table it appears that in respect of machinery our exports increased in ten years from 12·6 to 17 million pounds sterling, while Germany's advanced from 2·8 to 6·2 and America's from 2·6 to 9·5 in millions of pounds sterling. Apparently England is still the greatest exporter of machinery. But the trade of the United States has advanced

[1] A great increase in the export of agricultural implements took place in and after 1898—in 1900 the exports were valued at three times as much as they had been annually in recent years prior to 1898.

enormously, while that of Germany has advanced considerably. However, the growth of their old trade has not been so great as these figures would lead one to suppose. Many of the figures stand for new lines of trade. Take, for example, the kinds of machinery now exported from the United States : cash registers, type-writing machines, and electrical machinery are commodities of comparatively recent introduction into general use; and the value of these three classes alone amounts now to about 2,000,000*l*.

In engineering our most serious rivals undoubtedly are the United States and Germany, the former in particular. 'Every engineer,' wrote Sir Philip Magnus in 1902, 'knows the extent of our dependence on America for some of our most useful machinery. Our shops as well as our technical schools are largely fitted with American tools, and we are in danger of suffering in this country, not only from the superior inventiveness of our American cousins and their characteristic originality in grappling with commercial problems, but also from their ever-improving facilities for all scientific experiments.'[1] Such an expression of opinion, taken in conjunction with the figures set forth above, calls for a careful scrutiny of the facts. We shall examine mainly four chief branches of the engineering trade, namely those concerned with (1) locomotives, (2) agricultural implements, (3) machine tools, and (4) electric plant.

Since the great English Railway Companies prefer to build themselves the bulk of their rolling stock, our private locomotive-builders do not subserve a great national industry, as the makers of cotton

[1] *Engineering Magazine*, November 1902.

machinery subserve our cotton industry, and therefore we should scarcely expect to hold foreign markets easily by the superiority of our locomotives. American locomotive-builders, on the other hand, do supply the American railways, and undoubtedly the existence of such a large home market reacts in some degree on the quality of their output and their cost of production. It would seem that in general the condition of our locomotive-building, in relation to the American industry, is much the same as the condition of American ship-building for the foreign trade in relation to our corresponding industry, and for the like reasons. In view of these facts England's larger export of locomotives speaks highly for British efficiency.

Much has been said lately of the cheapness and efficiency of American engines. The Midland and Great Northern have recently bought some, and in some of the British colonies they are said to have proved more suitable occasionally for local conditions than locomotives from Great Britain. But thirty out of the forty American locomotives acquired by the Midland Railway Company have since been relegated to the scrap heap on the ground that their costliness in repairs, taken in conjunction with their performances at the kind of work done on British railways, did not justify further expenditure upon them.

Upon the matter of the comparative efficiencies of British and American locomotives two valuable reports have recently been received, the one from Burma and the other from Egypt. The facts revealed in these reports it will be instructive to

examine in some detail, but the reader must be warned that the failure of American locomotives under certain conditions does not establish their inferiority to British locomotives in general. For the class of work met with extensively in America the native locomotive may be the better, and in certain of our colonies for certain tasks it might be the wiser policy to buy engines from the great Baldwin works. However, to anticipate, it is pretty evident that the English locomotive is the more finished article; but whether our style of workmanship would pay in the United States now upon the whole is another question.

Mr. C. E. Cardew's report on the use of American locomotives on Burmese railways was made in 1901. Twenty locomotives were obtained from the Baldwin Locomotive Works of Philadelphia, and the following criticisms were passed upon them. In design they were patchy; parts of other types of engines had been adopted without having been fully adapted. No doubt this resulted from standardisation and the desire to avoid the expense which would be occasioned by the introduction of an entirely new element into the design. The coal consumption was said to be extravagant; the boilers did not steam freely; and the workmanship on the whole was not so finished as that of English locomotives. It was even said that the interchangeable parts were not so perfectly interchangeable on the Baldwin engines as on engines from British works. Again, it was asserted that low-grade steel, which scarcely deserved the name of steel, had been introduced here and there, though the material on the whole was good. With the

object of testing economies in working, trials were made with five of the Baldwin engines and five English ones under conditions which were stated to be absolutely identical. The results are given in the table below:—

—	Working days	Train-miles run	Quantity of wood consumed	Consumption per train mile	Percentage of excess of American over English
			tons	lb.	
English .	30	18,896	894·93	108·97	—
American .	30	17,057	1044·58	137·17	25·88

As regards price and the conditions of delivery, the Baldwin locomotives cost 1,750*l*. each, c.i.f., and were to be delivered in six months, while the British locomotives cost 2,000*l*., f.o.b. at Glasgow, and could not be delivered under eighteen months. As the freight and insurance from Glasgow amounted to about 105*l*., the Baldwin engines were 335*l*. cheaper than their British rivals. However, it is interesting to notice, as a comment upon the methods adopted sometimes to secure foreign markets, that when more locomotives were required, both the price and the time required for delivery had increased at the Baldwin works in such a degree that it was found more economical on the whole to place the new order with a British builder at 2,165*l*., f.o.b., for delivery in nine months. One explanation of the purchase of many of the locomotives now used on the Burmese railways was the need of augmenting engine power considerably at very short notice.

The second report to which reference has been made above proceeds from Egypt, and we might suitably preface this by a few words as to our trade

with Egypt as a whole. In 1895, 31·5 per cent. of the Egyptian imports came from England, in 1900 the percentage had grown to 37·5. Of the metal goods 34 per cent. was procured from the United Kingdom in 1895, while in 1900 as large a percentage as 59 was of English origin. As to rolling stock the following are the principal figures for the last four years of the nineteenth century:—

—	Total	United Kingdom	Belgium
	£	£	£
1897	29,485	7,617	17,654
1898	179,822	89,883	84,232
1899	246,171	59,125	178,015
1900	67,282	27,641	17,035

According to this table Belgium appears to be cutting us out, and Belgian locomotives are certainly very good; but the real explanation is that in consequence of the engineers' strike in 1897 English firms were so full of orders throughout the next year that they were unable to guarantee delivery in 1899.

In the House of Commons in May 1901 Sir Alfred Hickman drew attention to the report from Burma which has been referred to above, and asked that similar experiments should be conducted in Egypt. It was decided in consequence to make the trials suggested: the results are before us in the Blue Book from which we shall now quote. 'It appears that on seven recent occasions, when tenders for locomotives were invited, American offers were twice received. On both of these occasions the British were more favourable than the American prices, so long as the designs and specifications

prepared by the Egyptian Railway Board were followed. The actual figures were as follows:—British, 2,240*l*. and 3,250*l*.; American, 2,700*l*. and 3,575*l*. On the other hand the American firm (Messrs. Burnham, Williams & Co., whose works are known as the "Baldwin" Works) offered to supply engines differing in certain particulars from the Egyptian designs and specifications, but which they held to be of equal power and equally suitable for the work which had to be performed. Under these conditions the American prices fell respectively to 1,855*l*. and 2,475*l*., that is to say, 19 per cent. below the British. The reason for this great fall in price is sufficiently obvious; it is thus explained by Mr. Trevithick. The American firm, he says, "were able to introduce their stock standards and to advance work continuously without being hampered by, to them, unknown and unnecessary conditions: an advantage which, in my opinion, quite accounts for the difference in the cost and time of delivery between the two makes of engines."'

'It appears, however, that it is not so much in the matter of price as in respect of the period required for construction that the American manufacturers have had the greatest advantage, not only over British competitors, but over all others. The figures in this connection are, indeed, very remarkable. On the two occasions given by Mr. Trevithick when British and American firms entered into competition the former offered to complete the orders in forty-eight and in ninety weeks respectively; but the American firm was prepared to deliver in eighteen and thirty-five weeks if the Egyptian designs and speci-

fications were followed, or in twelve and thirty weeks if certain changes in the designs were allowed.'

As to the comparative values of British and American locomotives, Lord Cromer reports thus:—'It is, however, in respect of the relative consumption of coal that the recent trials are of special value. The most scrupulous care was taken to render the trials fair. On this point Mr. Trevithick says:—"These comparisons have been carried out under exceptionally favourable circumstances, inasmuch as the locomotives employed were typical of their respective countries in design and manufacture, and the trials were personally conducted, and the results conjointly signed by a representative sent out by the American builders and a locomotive inspector of the Egyptian Railway Administration." Trials were made with both goods and passenger engines. It was found that, in the case of goods engines, the American consumed 25·4 per cent. more coal than the British engine, while the latter was drawing 14·2 per cent. more load. In the case of the passenger engines the American was 50 per cent. more than the British consumption with the same average load. Major Johnstone, in reviewing these figures, says, speaking more especially of the passenger engines:—"The contrast between about 20 lb. of coal per mile in the best runs of the British engine, and over 60 lb. in the hardest runs of the American, is quite extraordinary. On the whole, the superiority of the British type is fully established; but it is clear that the passenger engine is a bad example of American practice."' The British passenger engine was said to ride more easily and require less attention on the

part of the driver and fireman than the American engine.

Upon the question of the efficiency of the Belgian engines in Egypt, the following report was rendered by Major Johnstone to Lord Cromer:—

'In the case of the Belgian- and British-made engines employed here, the design is identical, and the differences consist in material and workmanship.

'There is very little to be said against the Belgian workmanship, except against that part of the workmanship which is expended on making the materials harder and more durable.

'As regards coal consumption—which depends upon the evaporative efficiency of the boiler and the thermal and mechanical efficiency of the locomotive—there is practically no difference; the small differences I have noticed have been in favour of the Belgian, as against the English, but they are so small as to be within the limits of probable error of the experiments.

'There is no reason to suppose that there is any marked difference in the consumption of oil.

'The failures of the Belgian engines—and they have been very frequent—have been in most cases due to the materials of the boiler; but the materials of the engines also compare unfavourably in some cases with those of English engines. . . .

'I regret that I cannot give accurate figures as to the difference in cost of repairs. From statements received from Mr. Trevithick and from the Accounts Department I think that the difference in cost for the first five or ten years at least cannot be less than 50*l.* per engine per year, and there is no reason

to suppose that it can be more than 80*l*. After ten or fifteen years probably all the defective parts of a Belgian engine would be replaced, and the two engines would be virtually equal.'

The short time required for delivery and the low prices quoted by the Baldwin Company, on condition that American designs were accepted, are probably to be explained by the extent to which standardisation has been carried and highly specialised tools have been introduced. The same state of affairs is observable in American bridge building. The Pencoyd Bridge Building Company can turn out bridges of standard designs by the yard at a price at which an English builder could not as a rule undertake the work at a profit, and in the time which many English firms would require to think out the details of construction and collect materials. However, American bridges have been severely criticised. English civil engineers, it has been said, tend to diversify their designs needlessly and to pay little regard to standard girders and parts which are being produced regularly, whereas in the United States the bridge makers keep in touch with the steel makers, and introduce into their drawings as many parts that can be repeated as possible.[1] On the other hand there are dangers associated with the system of excessive standardisation and repetition upon which we need not dwell here; it may check originality in design, for example, and cause unsuitable plans to be accepted as sufficiently satisfactory. In the despatches from which we have quoted above Mr. Trevithick remarks that the American types of

[1] *Engineer*, April 21, 1899.

engines 'are an object lesson as to the disadvantages of standardisation when it prevents the introduction of improvements of design.'

Before we proceed further in examining the comparative state of affairs in the branches of engineering tabulated above it would be well to consider in which direction we should look for enterprise in each country's engineering. A country might be expected to manifest the greatest efficiency in producing that which it used itself most largely, as has been already suggested above. We should be prepared to find England exporting large quantities of cotton and linen machinery, and also of woollen machinery, in so far as it was of a kind which is in use here as well as abroad, and America exporting mining machinery, general pioneering machinery, agricultural implements, and — since American industrialism is a world of specialisation, standardisation, and cheap production in large quantities—machine tools also. Such anticipations would correspond fairly with the facts. America's backwardness in pushing its textile machinery abroad has already been commented upon. To Japan, for instance, textile machinery is sent regularly from England; and the Americans, in spite of their interests in the East, have apparently put forth no extraordinary efforts to oust us. Again, the stamp of English makers will be found on cotton and linen machinery all over the continent of Europe, while the mark of the American firm in Continental textile factories is seldom to be met with. It is natural that in the land of the most advanced and specialised textile industries the best and cheapest methods of

building the machinery employed in them should have been acquired, and that to this country other nations should look for satisfactory cotton textile machinery. In modification of this statement, however, it must be observed that in the cotton industry America has recently pushed ahead in some respects, and that already American automatic looms, many of which are made outside the United States upon payment of royalties, are to be found scattered over the places where cotton fabrics are produced. The following have been the values of our exports of textile machinery recently :—

1893	1894	1895	1896	1897	1898	1899	1900
£	£	£	£	£	£	£	£
5,256'	5,479'	6,152'	6,746'	5,702'	6,628'	6,804'	6,214'

(000's omitted)

It would be astonishing if America, with its developed engineering and iron and steel industries, and its large exports of agricultural produce, did not send agricultural implements abroad in large quantities; for they must be produced on a great scale to satisfy the needs of the United States and those of Canada, which cannot yet, with its natural resources but partially exploited, spare the labour to produce much machinery for itself. This explanation makes the state of affairs displayed by the figures annexed comprehensible :—

—	1899	1900	1901
	Thousand £	Thousand £	Thousand £
Agricultural machinery (not steam) exported from the United Kingdom . .	945	878	788
Agricultural implements and parts of implements exported from the United States	2,590	3,354	3,399

Production on a very large scale has made American agricultural implements cheap; and the American is ingenious in discovering devices by which the expenses of production may be diminished. Many agricultural implements turned out in the United States, for instance, have been simply dipped into tanks of paint, instead of being painted by hand, and moulding machines are extensively employed for producing the needful castings.

Since division of labour is conditioned by the scope of the market indirectly, and directly by the size of the business, it was in America, with its large-scale production combined with the restriction of the output to a few types, that the highly specialised machine tool was to be looked for. In contrasting the English and American manufacture of this kind of tool we must consider its efficiency, durability, and price, the time required for delivery by the makers, and the manner in which the machinery is offered for sale. Under certain of these heads it is easy to give a verdict on the competing claims. The American goods are the cheaper, and less time is required by American firms for executing orders; but English tools are the more durable. As to efficiency the machines of the two countries are about equal; but Americans introduce more new types than the English and produce the more highly specialised instruments. England may be said to hold its own in respect of trustworthy machine tools for general purposes; but it is America which manufactures the machine for making solely, say, some minute part of a watch or bicycle. Our purchases of bicycles in the United States used to be large, but they have

declined with the adaptation of British works to the manufacture of bicycles. At first the implements for their production were naturally obtained largely from the United States.

British Imports of Cycles (including those with motors) and parts thereof (in 1,000l.)

—	1897	1898	1899	1900	1901
From Germany . .	10·2	18·6	14·8	7·9	8·0
" Holland . .	5·4	12·1	9·1	11·1	12·7
" Belgium . .	8·7	18·4	8·7	8·0	10·6
" France [1] . .	39·5	27·2	26·4	28·2	24·6
" United States .	459·1	543·6	224·1	187·4	118·0
Total from all foreign countries. . .	524·3	611·2	285·3	193·8	174·7

In partial explanation of these figures it should be pointed out that the demand for cycles has been of an unsteady character for a variety of reasons.

Generally speaking, we may say that this country maintains its position in the manufacture of heavy tools, but that in the manufacture of the lighter machines the United States is ahead. Of the more specialised nature of the American machinery we have already spoken. It is built to turn out repetition work fast, and as a rule admits of little variety in the work to be done; in large specialised businesses in which it can be given full employment it has proved most economical. For the manufacture of machine tools American plants are also highly specialised: one firm

[1] In the manufacture of automobiles the French undoubtedly hold the first place to-day, though it is said that the United States is almost abreast. In the last three years the output in France has been trebled, and the manufacturers of bicycles are now devoting their attention to the new vehicles. In Lyons, Bordeaux, Marseilles, Lille, St. Etienne, Nantes, and Rouen, as well as in Paris, where the works have been famous for some time past, the industry will be found flourishing on a large scale.

may produce only two classes of milling machines and only two sizes of each. In England there is a tendency for the scope of work to be less restricted; and each system, needless to say, possesses advantages of its own.

It is said that the metal adopted in the United States for the construction of machine tools is softer than that used here, and that English machines are in consequence more lasting. However, the American metal if soft is tough, and does not tend to fracture. It is noteworthy that the lightness of the American tools, of which complaint has frequently been made by English purchasers, is explained as much by the more specialised tasks allotted to them in America as by the deliberate intention not to produce a machine which will outlive its period. The American machine is made only a fraction stronger than is absolutely necessary for the work to be done by it, the strain of which can be pretty accurately gauged; but 'in this country, where the work in an average machine shop is a great deal more varied than in America, it becomes necessary to allow a considerable margin of strength for contingencies.' Tools for heavy work are not made too light in American shops, but it is asserted that the soft metal of the sliding faces wears fast.[1]

German machine-tool construction is also inferior to American in respect of the lighter implements.[2] The German machine-tool industry is largely an

[1] Upon British and American machine tools an excellent series of articles and many letters appeared in the *Engineer* in 1898-9.

[2] See, *e.g.*, articles on 'American Machine-shop Practice from a German Point of View,' by Peter Lüders, in the *Engineering Magazine* for September 1901.

imitation of the American, but the Germans have shown original power in building heavy tools and a peculiar genius for constructing special machinery of an unusual type. Special work is more in accordance with German capacity than turning out rapidly and cheaply innumerable repetitions of the same machine. And the Germans are pre-eminent in working scientifically. Upon this point there appeared in the 'Times'[1] an interesting letter from an English foreman who had been sent by his firm to inspect some of the more modern workshops in Germany. He reported thus:—'The German tools for gauging and testing work are of the most improved kind, giving a positive reading to a finer degree than ours. Their methods of producing cutting tools for giving correct forms of thread &c. are excellent, and enable the workmen to proceed on well-defined lines with very great accuracy.' From this one would expect to find that the Germans standardise their work more than the English, which is actually the case; nevertheless standardising is said to be kept back in Germany by the disposition of buyers in that country to draw up long lists of conditions to be fulfilled by the machines which they require.[2] Americans, on the contrary, will trust their machine maker, look to him for ideas, and buy what is being made. The American seems to prefer buying ready-made goods; but the Englishman on the whole has a predilection for things made to order upon his own ideas. Each disposition, it is plain,

[1] July 18, 1901. The letter was sent to the *Times* by the foreman's firm.

[2] See article by Peter Lüders, in the *Engineering Magazine* for September 1901.

may be exercised to excess, and it would be difficult to draw a line of demarcation between the cultivation of peculiarities and the suppression of originality and a desire for perfection. It is true that the engineer knows his business, but it is true also that the customer knows the peculiarities of his own needs; and an excessive tendency to take what is made must ultimately have a stagnating influence. As to labour, to return to German conditions, the English foreman whom we have quoted above reported that the German hands were efficient, orderly, and interested in their work, and that they put forth their best efforts; moreover he declared that the works were neat and well arranged.

To sum up upon the question of cost, we may say that American tools are cheap because (1) little labour is spent upon the finish, (2) raw material is bought in large quantities, (3) the specialisation of businesses allows of the specialisation of machinery, and (4) the tool produced is confined as a rule to one or a few purposes, and can therefore be made just strong enough and efficient enough for its restricted use. As regards the fourth reason, it is apparent that the English machine, in being made strong enough to cope with some unforeseen task upon which it might be employed, is rendered too strong, and therefore expensive, for the work to which it is usually applied. It is obvious, let us notice in this connection, that the economy of the specialised tool is affected by the space which it occupies when idle and when working, as well as by its cost, performances, and the amount of work which exists for it to do.

We have mentioned above, as one of the considerations to be borne in mind in contrasting American and English machine tools, the manner in which they are offered for sale. The machine which is guaranteed, and watched by its maker through his agents to insure that its performances shall be equal to its capabilities, is more valuable than the machine which is not guaranteed and in which the maker takes no further interest after it is sold. In the latter case the purchase is merely a piece of mechanism which may or may not be understood fully by the purchaser; in the former case it is a guaranteed amount of work and includes further some share in the services of a person of trained intelligence who is perfectly acquainted with the appliance. English manufacturers are disposed to argue that since machines may be ill-used, and might be more carelessly used if they were guaranteed, guarantees are better avoided on the whole. Recently British locomotive makers, for example, refused to guarantee coal consumption when tendering for locomotives to be supplied to Egypt, although economy in coal consumption was a matter of fundamental importance in consequence of the high cost of coal in Egypt. Such guarantees, however, are no longer refused. The American engineer, on the other hand, argues that normally a machine will not be treated in any appreciable degree more roughly when it is guaranteed, for it has been bought because it is wanted, and that the guarantee may make all the difference in deciding a hesitating customer. There is something in the view that the responsibility for the performances of a machine

should rest partially on the makers, who understand it best, especially when machine makers are attempting to introduce new ideas. The American does not object to risks when by bearing them he is assisted in pushing new machinery. Sometimes the American seller will provide a man to work his machine for a short time and give instruction in managing it; sometimes he will send the machine with a 'minder' on approval without any understanding being entered into as to purchase should the tool prove satisfactory. He trusts to demonstrating the value of his tool if only he be given a chance. This attitude begets confidence in the buyer. Again, the American seller will call at intervals to observe his machine at work, and this continued interest on the part of the seller means that the utmost value is extracted from his goods. If the machine is not receiving fair treatment the representative of the makers will discover the fact, and if its performances are below its capacity he will explain what changes ought to be made in handling it. The result is that those who would otherwise be afraid of introducing a new tool because of the trouble involved in understanding it and fitting it into their working system find the path off the beaten track made so easy for them that they no longer hesitate to commit themselves to it. When every machine that is sold is nursed by its makers in this way, few prove failures and the tool earns a great reputation. There is little doubt that American makers are more ready to guarantee their machines, and have them reported upon periodically by experts, than English makers.

One cause of the cheapness of American tools is

the extent to which malleable and steel castings are used for some of their parts and the degree in which machinery is used for moulding them. The malleable casting, which is freed from the chief defect of ordinary castings—that is, brittleness—by a process of annealing, is beginning to displace in no small measure the more expensive forgings in American metal work. The automatic couplings, for example, on American trucks are malleable castings, and they are said to serve their purpose fairly well on the whole, though recently complaint has been made that fractures are rather too frequent. As more castings are used in American designs than in English ones, we can imagine that the use of machinery for moulding purposes has advanced further in the United States than here. To take one example, the McCormick Harvesting Machine Company of Chicago possesses no fewer than 300 moulding machines, and these are said to have lessened the cost of production in a considerable degree. The following contrasts for eight different mouldings, which are quoted from the 'Engineer,' are put forward on the authority of the McCormick Company:—

	Cost when made by hand *d.*	Cost when moulding machines used *d.*
Casting No. 1	4·0	0·9
" " 2	3·75	0·8
" " 3	4·0	0·9
" " 4	0·5	0·08
" " 5	0·3	0·06
" " 6	6·0	1·5
" " 7	4·0	1·0
" " 8	1·5	0·37

The cost of core making is not included in these

figures. On an average the cost of moulding was reduced from 2*l.* to 11*s.* per ton. It should be pointed out that it is not so much conservatism as the great variety of work undertaken by an average British firm which prevents the extended employment of moulding machinery in this country.

American engineering in general is certainly highly efficient. In every shop almost all the shifting of material and machinery, including much that would be done in even a first-rate shop by hand, is effected mechanically with remarkable precision and a celerity which confounds the visitor. In big works the 'Goose-neck' device for pushing heavy objects in any direction, 'live' rollers, and electric cranes commanding the whole shop-space, to which electro-magnets are sometimes attached in the place of hooks for lifting steel, are usual features. Expensive and highly skilled labour is economised in every possible way. Frequently electric bells are provided, within easy reach of the machinists at their tasks, for summoning boy messengers and assistants. Thus time need not be wasted if common foresight be exercised. Small casual jobs are done for the machinist by cheaper labour. The American manager is convinced that he cannot afford to pay men 3*l.* or 4*l.* a week to do messenger's work and porterage. Again, tools are ground by special grinders, and no doubt they are sharpened the better in consequence. One noticeable difference between the arrangements here and in America is that the works in the latter country do not open before breakfast. In the United States the general impression to-day is that little good work is done

before breakfast, and that the time spent in the shop during that period of the day or night diminishes the efficiency of the operatives towards the end of the day.[1]

In a recent address on the comparative efficiency of American and British engineering industries Mr. F. A. Halsey, an American, said that, speaking 'broadly of the product and adaptation to its work, American engineering is not now better than that in England. Our engines, our locomotives, our boilers, and our bridges are no better than those made abroad, though often better adapted to local conditions. The sale of these products abroad is usually due to quicker delivery, or lower price, or both.'[2]

It would not be correct to say that the American master in the engineering industry is a more efficient expert than his rival in any other country. Probably the most highly trained theorist is the German; and the Englishman is not as a rule inferior to the American in respect either of technical or theoretical acquirements. But the American engineer is in addition alert, pushing, adaptable, resourceful, quick to see and seize opportunities, a thoroughly good buyer and seller, and a splendid works manager. Frequently very young men are to be found at the head of affairs, and for early promotions it is argued that if the youthful manager is at first lacking in sound judgment and caution his responsibilities soon correct these defects, and he is at any rate imagina-

[1] The articles in the *Times* on 'American Engineering Competition,' which have been republished in book form, contain much useful matter, if they do draw a contrast somewhat too unfavourable to British work.

[2] *Chemical Trade Journal*, February 17, 1901.

tive, sanguine, elastic in mind, and enterprising. In Germany the system which tends to be brought about in the shops is described as almost of the character of military organisation, with the chiefs on the one hand, the mere executive agents on the other, and the rigid discipline. On the contrary in American shops the men are said to be taken more into the master's confidence and encouraged to assist him in bringing designs to perfection. Hence no doubt the number of slight improvements and clever devices which originate in America. Every workman is encouraged to be an inventor in a small way; and if the improvement suggested by a workman is one that economises labour no attempt is made as a rule to cut his piece rates so long as he remains at his old job. Hence hampering restrictions are imposed less on the use of machinery by the trade unions, and piece rates are regarded with less suspicion, on the whole, in the United States than in the United Kingdom. The unity of director and workmen co-operating to achieve the same end, each stimulated by the certainty of personal gain if success be achieved, prevents it. And the American 'machinist' earns far higher wages than the skilled British mechanic, while the labour cost of production is no higher in the United States than here. Yet from the evidence given by Americans who have worked in England, and Englishmen who have worked in the United States, we cannot conclude that the American workman is more capable than the English workman; rather, we should say, the spirit of the American's surroundings, the constant movement, and the system in which he works, are more

likely to bring the workman's powers into full exercise than the corresponding conditions in England.[1]

Let us now consider the trade of electrical engineering. The following tables have been constructed from such figures as are available. It must be noticed that the class of goods to which the American figures refer is much wider than the class to which the first lot of English figures refer.

(Figures given in thousands of pounds sterling)

Electric Lighting Apparatus, or Parts thereof (except Steam Engines), exported from United Kingdom.

1886	1887	1888	1889	1890	1891	1892	1893
£	£	£	£	£	£	£	£
88'	99'	166'	211'	281'	289'	175'	215'

1894	1895	1896	1897	1898	1899	1900	1901
£	£	£	£	£	£	£	£
246'	886'	382'	449'	515'	511'	546'	553'

Electric Goods and Apparatus imported into United Kingdom (not distinguished).

1897	1898	1899	1900	1901
£	£	£	£	£
242'	367'	613'	1,266'	849'

Electrical Machines, and parts of, exported from United States.

1898	1899	1900	1901
£	£	£	£
428'	570'	904'	1,211'

Imports of Electrical Goods[a] into England from the following Countries.—

	1900	1901
	£	£
United States	833'	388'
Germany	87'	74'
France	140'	124'
Belgium	77'	87'

[a] Not distinguished prior to 1900.

[1] In addition to the evidence already given we might mention here: 'An English Mechanic in America' in *Engineering*, February 22, 1901; an article in the *Iron Age* for April 3, 1902; 'American Machine-shop Practice from a German Point of View' in *Engineering Magazine* for September 1902; 'British View of American Methods of Manufacture' in

In industrial efficiency, in respect of electrical engineering, England is said to be surpassed by foreign rivals; but given two nations at about the same general level of industrial development, when the influences of exchange have settled the lines of specialisation of each, the highest degree of efficiency in any trade must be looked for where the output of that trade is largest and the division of labour therefore greatest. Professor Ayrton writes:—'If you want a piece of electrical machinery constructed according to a well-drawn-out specification do not send to an English firm. For dynamos manufacturers send to Germany; for magnet steel, to Germany or France; for the material for resistance coils, to Germany; and for the paper used for insulating underground cables, to America.'[1] In somewhat the same strain a contractor and electrical power engineer said, in giving evidence to the Departmental Committee on Electricity in Mines sitting at the Home Office, that whenever he required electrical machinery for work on a large scale he had to procure it from America, Germany, or Belgium, and that we were at least four or five years behind those countries in the application of electrical machinery.

The want of scientific knowledge has been ascribed as one cause of our present position; and no doubt there is a tendency in this country to underrate in highly technical industries the importance

American Machinist for January 4, 1901; 'English and American Continental Steam Engineering' in *Engineering Magazine* for November 1901; 'Experience of an American Shop Manager in England' in *American Machinist* for November 28, 1901; Reports of the Mosely Commission.

[1] Report of the London County Council Technical Education Board.

of scientific attainments in comparison with business ability. In Germany, according to information acquired when the Institute of Electrical Engineers visited that country, the proportion of trained persons, who are more or less experts, to the numbers employed altogether is remarkably high.[1] As many as 70,000 persons are engaged in the manufacture of electrical apparatus in Germany; but in England and Wales the workers of the same character number nearly 50,000. Yet the wages in factories which produce electrical apparatus are lower in Germany than in England.

In some respects America appears to be leading in the electrical industry. In contrast with America, Germany is said to have introduced few original practical ideas. The English delegate to the Congress of the American Institute of Electrical Engineers held in New York in August 1901 reported thus:—'Beautiful systems of control of labour-saving schemes are perhaps the greatest advance to be seen in the United States: the arrangement of pneumatic and motor control for switches, so that the whole huge system of high-tension machinery can be regulated by one man without moving, is one object lesson in labour economy. But,' he added, 'it is open to doubt whether, on the whole, English engineers need consider themselves behind their American confrères.'[2] The advance made by the Americans is the outcome of their practical enterprise, and in the United States a rapidly expanding market has encouraged the new industry. The use of electricity in any considerable degree is of recent

[1] *Engineering*, August 2, 1901. [2] *Electrician*, September 20, 1901.

date: in England, on the whole, it is still viewed with much doubt, and many employers are still unwilling to take the risk of introducing electrical plant; but in the United States risks have been courted rather than shunned, and the ventures which electricity offered have received an eager welcome. This buoyant spirit of enterprise reaching out to all that is new, whatever the risks, if it but hold out promise of gain, has directly and indirectly created the efficiency of the American electrical industry.

These figures from the Twelfth Census indicate how great has been the recent growth in the United States:—

Electrical Apparatus and Supplies.

—	Capital in million $	Wage earners (exclusive of clerks and salaried officials)	Total wages paid in million $	Value of product in million $
1880	1·5	1,271	·68	2 7
1890	19·0	8,802	4·52	19·1
1900	83 1	40,890	20 19	91·3

CHAPTER V

THE COTTON INDUSTRY

To form an idea of the comparative importance of the cotton industry in each country it will be necessary to examine (1) the relation of exports to imports in each country, (2) the number of spindles and looms possessed by each, (3) the number of operatives engaged in the industry, and (4) the quantity of cotton and yarn consumed. But none of these sets of figures will afford a perfect indication of the size of the industry in each country. From statistics as to imports and exports, for instance, we can glean nothing as to the magnitude of home markets, which of course vary partially as the population. Again, the second and third groups of figures are misleading, because machinery is not always the same—looms, for instance, may be hand-looms, power-looms, or automatic looms—machinery runs at different speeds, the ratio of machinery to operatives is not the same throughout the world, and the quality of labour varies. And figures under the fourth heading give no information about the value of the product, for yarns and fabrics may be coarse or fine.

The following table shows the relation of exports to imports in each country:—

Trade in Cotton Goods (Yarns, Cloths, and others) of some of the Principal Countries (000's omitted).

—	1895 Imports	1895 Exports	1895 Excess of imports or exports in £. Excesses of exports in brackets	1899 Imports	1899 Exports	1899 Excess of imports or exports in £. Excesses of exports in brackets
Russia (silver roubles) .	6,206	9,061	(135)	18,282	10,817	460
Norway (kroner) . .	9,659	2,015	425	9,838	187	539
Sweden (kroner) . .	11,450	8,482	443	11,601	575	618
Germany (marks) * .	70,905	200,992	(6,504)	88,161	229,695	(7,077)
Holland (gulden) . .	45,108	41,886	272	42,452	89,107	279
Belgium (francs) . .	30,252	27,556	108	35,649	25,437	408
France (francs) † . .	49,721	118,264	(2,742)	51,522	179,715	(5,128)
Switzerland (francs) .	30,231	128,540	(3,933)	34,425	52,669	(730)
Portugal (milreis) . .	2,078	675	315	3,092	2,420	151
Spain (pesetas) . .	11,967	48,384	(1,257)	10,658	41,159	(1,220)
Italy (lire) . . .	17,256	—	690	9,490	42,429	(1,318)
Austro Hungary (gulden)	19,807	5,961	1,154	14,972	7,038	664
Greece (drachmas) .	10,558	—	422	14,371‡	—	575 ‡
Bulgaria (francs) . .	12,055	—	482	12,649	—	506
Roumania (lei) . .	29,374	—	1,175	47,471	—	1,908
Egypt (£ Egyptian = 100 piastres) . .	1,473	—	1,509	1,907	—	1,956
United States (dollars) .	33,197	18,790	4,042	36,581	24,850	2,442
China (H. taels) . .	58,074	—	8,846	108,465	1,231	16,145
Japan (yen) . . .	14,321	8,952	1,090	15,587	33,512	(1,797)
Chili (peso fuerte) . .	8,209	—	1,299	14,199	—	1,065
Uruguay (peso fuerte) .	2,562	—	535	2,457	—	512
Argentine Republic (peso nacional) . .	17,790	—	856	18,862	—	2,772
India (pounds sterling) .	19,833	6,642	13,191 (1896–7)	19,634	6,413	13,221 (1899–1900)
United Kingdom § (pounds sterling)	3,821	63,735	(59,914)	4,946	67,547	(62,601)

* Bremen and the greater part of the town of Hamburg were included in the Zollgebiet in 1888, but the Zollverein is still exclusive of the free ports of Hamburg (Freihaven Hamburg), Cuxhaven, Bremerhaven, Geestemünde, and of certain parts of Baden. In 1889 the Zollverein imported cotton goods to the value of 71,089,000 marks, and exported goods to the value of 181,560,000 marks, and so had an excess of exports of 5,524,000*l*.

† France had an excess of exports in 1860 of 2,358,000*l*.

‡ In 1898.

—	—	Reduced by index numbers to the values of 1895	Reduced by index numbers and expressed per head of the population
	£	£	£
§ United Kingdom, excess of exports in 1854	31,746	19,300	·70
" " 1873	72,897	40,775	1·27
" " 1895	59,914	59,914	1·58
" " 1899	62,601	57,077	1·407

From this table we may infer, to give one example of interpreting it, that the cotton industry in America

must be of considerable size, since it satisfies in effect the total requirements as regards cotton goods of a population amounting to more than seventy-six millions in the United States alone, except for a trifling quantity of some two to four million pounds sterling in value.

The conclusions suggested by the foregoing figures find some corroboration in the following estimates made by Mr. Thomas Ellison, of Liverpool, in 1898 as to the number of spindles in operation in the countries stated:—[1]

Country	Spindles	Percentage of total
Great Britain	44,900,000	44·75
United States	[17,356,537 [2]]	[17·30]
North	13,900,000	13·85
South	3,456,537	3·45
Germany	7,884,000	7·86
Russia	6,000,000	5·98
France	5,300,000	5·28
India	4,065,618	4·05
Austria	3,140,000	3·13
Spain	2,615,000	2·61
Italy	1,886,000	1·88
Switzerland	1,710,000	1·70
Japan	1,150,000	1·15
Poland	965,000	·96
Belgium	900,000	·90
China	565,000	·56
Canada	491,252	·49
Mexico	448,156	·45
Sweden	360,000	·36
Holland	290,000	·29
Portugal	230,000	·23
Greece	70,000	·07
	100,326,563	100·00

In addition a few spindles are at work in Brazil, Turkey, and Egypt.

[1] *Statistics of Manufactures of Massachusetts*, 1898, p. 262.

[2] The number is said by other authorities to have been 19,410,554 in 1898. See *Statistics of Manufactures of Massachusetts*, 1898, p. 256.

With these compare the estimates for 1900, which appear in the last census of the United States :—

Country	Spindles
Great Britain	45,400,000
United States	18,590,515
Germany	7,155,500
Russia	6,090,889
France	5,089,000
India	4,945,783
Austria	3,140,171
Spain	2,614,500
Italy	2,092,780
Switzerland	1,709,400
Total in the world	103,883,386

The Home Office has returned British spindles for 1903 as 47,857,000, of which 3,952,000 are doubling spindles.

Some further indication of the relative importance of the industry in different places is afforded by statistics of the consumption of cotton. Experts estimated that Great Britain consumed 3,380,000 bales of 500 lb. each in 1897–8, while the United States consumed 2,962,000, the continent of Europe 4,576,000, and India 1,058,000 bales.[1] The consumption of England seems comparatively low, but it must be borne in mind that British spinning is on the whole much finer in quality than that of any other country.

To observe the recent growth in the consumption of cotton by these districts respectively, we might glance at the state of affairs in two quinquennial periods. It has been calculated that the average annual amounts of cotton worked up by the groups of spindles tabulated above were as follows (in bales of

[1] *Statistics of Manufactures of Massachusetts*, 1898, p. 252.

500 lbs.), in the five years ending in 1895, and in the next five years, exclusive of the quantity consumed in hand-spinning in India, China, and elsewhere:—[1]

	1891–5	1896–1900
Great Britain	3,161,000	3,356,000
Continent	3,874,000	4,586,000
United States of America	2,541,000	3,367,000
India	994,000	1,171,000
All other countries	270,000	752,000
Total	10,840,000	13,232,000

The world's power-looms producing cotton goods have been estimated by Mr. Samuel Andrew, secretary of the Oldham Master Spinners' Association, at the amounts stated below. Side by side with them we have given the figures as to spindles put forward by the same authority, as it might be useful to compare them with the other calculations quoted above.

Country	Spindles	Looms
Great Britain	49,727,107	719,889
United States, North	14,500,000	335,000
United States, South	6,714,000	153,000
Russia	6,000,000	146,000
Poland	850,000	12,000
Germany	8,434,000	212,000
France	6,150,000	106,000
Austria	3,250,000	110,000
Switzerland	1,558,000	15,500
Italy	2,435,000	110,000
Spain	2,614,000	68,000
India	5,000,000	43,000
Brazil	300,000	15,000
Canada	773,000	18,000
Mexico	500,000	15,000

Germany and the United States are obviously seats of the cotton industry of considerable importance. Germany now possesses more than one-sixth

[1] See the paper read to the Manchester Statistical Society by J. Arthur Hutton in February 1904.

as many spindles as are working in England, and more than one-quarter as many power-looms. In the period 1836–40 German spindles consumed on an average about 9,000 tons of cotton per annum; in 1856–60 the amount was 46,000; by 1876–80 it had become 124,000; in 1886–90 it was 201,000; and by 1899 it had reached the large figure of 313,000.[1] Some of the increase after 1870, however, is due to the inclusion of Alsace and Lorraine in the German Empire after the war. In 1895 Alsace possessed about a million and a half of spindles and some 38,000 looms. The expansion in the last decade of the nineteenth century, in which the consumption of cotton by German spindles increased as much as 56 per cent., is certainly most impressive; but even in previous decades the percentages of increase had been considerable, namely, more than 30 between the averages of 1871–5 and 1881–5, and about 66 between those of 1881–5 and 1891–5. Yet, enormous as was the growth of the consumption of cotton in Germany in the last ten years of the nineteenth century, it was little greater than the growth in India, and much less than that in the United States. Comparing the year 1888–9 with the year 1899–1900 we find Great Britain advancing from a consumption by her spindles of 681,000 tons to one of 794,000 tons, while the United States increased its use of cotton from 476,000 to 862,000 tons, and India increased its use from 158,000 to 227,000 tons. Thus the percentages of increase were 81 in the United States and 44 in India, compared with about 17 in Great Britain.[2]

[1] *Deutschland als Industriestaat*, by Dr. F. C. Huber, 1901, p. 485.
[2] *Ibid.* pp. 485, 486.

Further, the German trade recently felt itself strong enough to sever its direct connection with the Liverpool cotton market. In 1886 a cotton market, from which now the spindles of Germany, Switzerland, Austria, Poland, and part of Belgium are naturally fed, was established at Bremen, and to-day its dealings surpass in magnitude those of the market at Havre which had been set up earlier.

The extent of manufacturing may be indicated in general by the quantity of yarn consumed, though, if the latter is expressed only in weight, we cannot learn from it the length or fineness of the fabrics produced. Germany worked up on an average 211,000 tons of yarn per annum in the period 1891–5; in 1866–70, 1871–5, and 1881–5 the amounts had been 66,000, 109,000, and 134,000 tons. The relation of home production to consumption in Germany is shown in the table annexed, in which the figures represent thousands of tons and express the average annual amounts in the periods stated:—[1]

—	Home production	Imports	Exports	Consumption
1856–60	37	26	2	61
1871–5	93	21	5	109
1881–5	123	19	8	134
1897	232·6	26·4	7·9	251

The number of spindles in Germany to-day is probably more than eight millions; in 1836 it was 626,000; in 1863 some two millions; in 1881—after the enlargement of the empire—about 5,100,000. The number of persons employed is stated to be 222,000—75,000 in spinning and 147,000 in weaving.[2]

[1] *Deutschland als Industriestaat*, by Dr. F. C. Huber, 1901, p. 436.

[2] *Ibid.* p. 437.

In England the total number of cotton operatives in 1898 was 526,107, or a little less than 2½ times as many. Of the population of the United States 302,800 were returned as cotton operatives at the twelfth census (1900), and in the last ten years that number must have increased in spite of the frequent introduction and ready adoption there of labour-saving methods. It is needless to point out again that the numbers of operatives working in different countries may easily confuse our ideas of the comparative importance of the industry in those countries, since the effectiveness of labour absolutely is not the same in all places, and it is conditioned by the efficiency of machinery; antiquated looms, for instance, may be employed in one country, while in another some twelve to twenty Northrop, Harriman, or other automatic looms may be managed by one man.

The growth of the cotton industry is even more impressive in the United States than in Germany. In 1809 the United States possessed eighty-seven mills, containing 80,000 spindles; [1] now their spindles are said to number over twenty millions. The following table, compiled from the eleventh census and later figures already given, shows the rate of growth for the last twenty years (000's omitted in columns 1, 2, and 4):—

—	1880	1890	Percentage of increase in previous decade	1898	Percentage of increase in previous 8 years
Active spindles	10,653,	14,188,	33·8	19,411,	37
Looms . .	226,	325,	43·90	458,	39
Pounds cotton consumed .	750,344,	1,117,946,	48·99	1,930,880,*	73 †

* In previous decade. † 1899-1900.

[1] *Statistics of Manufactures, Massachusetts*, 1898, p. 255.

Other countries besides Germany and the United States have emerged from the position of extreme relative inferiority in which they were left after the industrial revolution had worked itself out in England. Russia, we have already seen, possesses some 6,000,000 spindles; France some 5,300,000; India 4,065,618; Austria 3,140,000; Spain 2,615,000; Italy 1,886,000; Switzerland 1,710,000; Japan over a million, and Poland and Belgium nearly a million. In most of these cases development has been fairly recent. In 1868, for instance, Italian spindles numbered 450,000; in 1876 they reached 745,300; by 1898 the second million was passed, the number of spindles, including those used for twining, being 2,092,000. Of the Italian spindles, it may be remarked here, two-thirds are driven by water-power and run day and night. Long hours and double shifts enable them to compete with the product of Lancashire when placed in their own and contiguous markets. In 1899 Italy actually had an excess of exports of cotton, yarn and manufactures, valued at 1,318,000*l*. As a rule, however, Italian work is coarse: the average counts in 1876 were 16's and in 1898 about 22's, though some mills indeed were turning out finer yarns up to 120's and even 160's.[1]

Bombay, again, is rivalling Lancashire in Indian and Eastern markets in respect of yarns. The first cotton mill was opened in India in 1851; in 1876 Indian spindles numbered 1,100,100 and Indian looms 9,100;[2] in 1896–7 the spindles were 3,976,000 and the

[1] *Special-Nummer IV. der Leipzige Monatsschrift für Textil-industrie.*

[2] *Ibid.*

looms 37,300; by 1900–1 these numbers had become respectively 4,933,000 and 40,500. It is said that the yarn produced annually now is above 500 million pounds in weight (more than ten times the average annual imports of yarn between 1896 and 1900) and that the yearly output of cloth weighs between 90 and 100 million lb. However, it must not be forgotten that in the period 1898–1901 India's average imports of cotton yarn were valued at about 1·6*l.* millions, while those of cotton cloth stood at 17·5*l.* millions. About 73 per cent. of the Indian mills are in Bombay, and the counts produced are, as a rule, below 20's, since native cotton is not suitable for fine spinning. But the range of Indian work is extending; Mr. H. J. Tozer, who is well acquainted with Indian affairs, has even suggested that 'the general progress of the indigenous industry, seen in the wider resort to fine spinning and in the increasing number of up-country mills for the supply of local wants, points to a time when India will be able to furnish practically the whole of the cotton goods she requires.'[1] But that such a time, if it ever arrive, is far distant, one would infer from the figures previously given. And although some fine work is being done, as much as 85 per cent. of the Indian output of yarn to-day is of 20 hanks to the pound or less, while only an insignificant amount of the remainder is of a quality finer than 30's. According to European and American reckoning, 30's are well within the class of yarns known as coarse. Yet India is supplanting us as an exporter of yarns to the East. Between 1876–7 and 1890–1 the exports of yarn from India to China (including

[1] *British India and its Trade*, p. 85.

Hong Kong) steadily grew from 7·9 to 161·2 millions of lbs., while in the same period the exports from the United Kingdom to the same markets never reached 48 millions. To-day the value of India's export of yarn to China (including Hong Kong) is some ten to fifteen times greater than the value of our exports of yarn to the same markets, which have recently been beneath half a million in value invariably. However, the value of Indian piece goods sent to the same places is insignificant, while the value of those brought from England approached an annual average of 5,000,000*l*. in the period 1897–1901. Most of the Indian exports of yarn reach China: to Japan very little is sent; in 1879-80 the amount of yarn forwarded to Japan was only 1,814,090 lb., and in 1899–1900 it had fallen to 180,000 lb. Japan has been enterprising in developing its own cotton spinning to feed the native hand-looms (for there are few power-looms), and to-day it possesses one million and a quarter spindles—a quarter as many as India. On the other hand the attempt made—largely by Europeans—to establish cotton spinning in China has proved a failure, and, according to Mr. Helm, the capacity of the Chinese mills is probably no more than 700,000 spindles.[1]

England still leads in the manufacture of cotton textiles, but at no immeasurable distance from two powerful rivals at least, and a large part of the Eastern market for yarns has been wrested from her by one of her dependencies, India. These facts call for a careful examination of the economic forces at present working, and in particular for an inquiry

[1] *Statist*, August 30, 1902.

into our efficiency in relation to that of other countries.

Let us first examine the situation in the East. This was investigated by the Manchester Chamber of Commerce in 1888,[1] and the state of affairs is not materially different to-day from what it was then. The evidence proved that British industrial supremacy was so marked that Lancashire paying high wages to operatives working fifty-six and a half hours per week [2] could produce true 20's bundled mule yarn at a cost from ·25*d*. to ·45*d*. per lb. cheaper than Bombay, paying from 5*d*. to 1*s*. 6*d*. a day [3] to spinners—of which far more were needed to tend a given quantity of machinery than in England—working about eighty hours a week in mills open for 350 days in the year on the average, that is, some forty days more each year than is usual in Lancashire. The successful competition of India was attributed in part to geographical conditions and in part to disturbances in the exchanges. The majority report held that the former were quite sufficient to explain the facts. Lancashire, to compete in the East, must bear the expense not only of importing raw cotton, but also of carrying the yarn half round the world: India grows cotton and sells the yarn at home or in a market far closer to her mills than to Lancashire, but she has to import machinery and coal. It was calculated that Lancashire through the cost of carriage of raw cotton and again of the yarn was selling at a disadvantage of $\frac{13}{16}$ to $\frac{7}{8}d$. per lb.

[1] *Bombay and Lancashire Cotton Spinning Enquiry: Minutes of Evidence and Reports*, 1888.

[2] Now fifty-five and a half.

[3] *Wages in Commercial Countries*, U.S.A. Reports, 1890.

in Indian markets and of $\frac{3}{4}d.$ per lb. in China. These costs were only in a small measure counterbalanced by the Bombay spinner's disadvantage in having to import his machinery and coals. Moreover the trade between India and China had been encouraged in 1875 by the removal of the 3 per cent. duty on yarns exported from India, and for a long time competition in Indian markets had been checked by the duty of $3\frac{1}{2}$ per cent. levied on imported yarn.

Upon the disturbances introduced by fluctuating exchanges after 1873, and before the closure of the Indian mint in 1893, we need not dwell, since trade subsequent to 1893 has demonstrated that this was only contributory to the main causes with which we have already dealt. The important point for our purpose is that the labour cost of production in India in mills at work for 350 days of about eleven and a half hours each with swarms of hands, in comparison with the numbers needed in English mills, receiving a weekly wage only a fraction of that paid in Lancashire, was in 1888 far higher even for the coarsest counts than the labour cost in Lancashire, where the weekly hours of labour were fifty-six and a half and the days worked in the year some 306. The Indian operative possesses less endurance, less persistency, and less power of continuous application; all classes of labour are constantly changing in an Indian mill. The number of operatives required to manage a given quantity of machinery was five to eight times greater in India than in England, and now it is at least three times greater. It is the advantage of position alone which has enabled the native industry to oust foreign yarns, except a few

the bulk of which are coloured. Those who were inclined to attach importance to the fall in the rupee as a cause have argued that the geographical advantages were greater before 1873, and that they have steadily diminished, whereas the industrial awakening of India has taken place almost entirely since 1873. It must be remembered, however, that the percentage of the cost of carriage to the total cost of yarn has not fallen so greatly as the cost of carriage alone; and, further, that other causes, namely, enterprise, readiness to face change, powers of application and adaptation, and docility to discipline, have been steadily increasing in India.

The East is far behind us in efficiency, but what of the West? The magnitude of the cotton industry in the United States, Germany, and France, at least suggests that the space which admittedly lay between their stages of industrial development and ours half a century ago is fast diminishing. Let us first ask how our efficiency compares with that of others, and then consider the causes for their encroachments on the markets which in the past looked always first to Great Britain.

In 1871, in a lecture before the Philosophic Institute of Bradford, Mr. Alexander Redgrave discussed the question of the industrial efficiency of different nations and gave the following figures as to the proportion of spindles to persons employed in the cotton factories of the various Continental States:—

In France	14	In Belgium	50
" Russia	28	" Saxony	50
" Prussia	37	" Switzerland	55
" Bavaria	46	" Smaller States of Germany	55
" Austria	49	" United Kingdom	74

'Incidentally,' he added, 'the following statements have been made to me by managers of cotton factories showing the relative capacity of work of the Englishman and foreigner. In Germany the working hours were (at that time) from 5.30 A.M. to 8.30 P.M. every day, including Saturday. In a cotton factory there, a manager calculated that the same weight was produced when superintended by English overlookers as in sixty hours in England; but if the work was superintended by German overlookers, the weight produced would be much less. As another instance, in Russia the factories work night and day, one hundred and fifty hours per week, there being two sets, each working seventy-five hours per week. Taking the year round, the manager of a cotton factory there considered that in England as much would be produced in sixty hours per week. He also said that no weaver ever had more than two looms, and that the speed of the machinery was about one-third less than in this country. Some few years since I had opportunities of inquiring into this subject, both in France and in Germany, and from every quarter, and, especially from English overlookers, I received the strongest assurances that the English workman was unapproachable in the amount of good work turned out, and in steadiness; that the relative cheapness of wages did not counterbalance the steadiness and the quickness of the Englishman at his work.'

Corroboration of this view, as regards France at any rate, can be found in the writings of M. Taine. In his 'Notes on England,' he writes: 'French manufacturers tell me that with them the workman

labours perfectly during the first hour, less efficiently during the second, still less during the third, and so goes on diminishing in efficiency, until in the last hour he does little good at all. His muscular force flags, and, above all, his attention becomes relaxed. Here (in England), on the contrary, the workman labours as well during the last as the first hour; but, on the other hand, his work-day is one of ten hours, and not of twelve, as with us. By reason, however, of this better sustained attention, the Englishman gets through more work. At Messrs. Shaw's, of Manchester, to manage 2,400 spindles, one man and two children are found sufficient; in France it needs two men and three, four, and sometimes more children for the same purpose. . . . But in certain qualities, as in the matter of taste, artistic finish, and the like, the Frenchman has the advantage. He is more imaginative, less mechanical; and, by consequence, that power of concentration, of stubborn, persevering, and sustained application where the labour is monotonous, which so distinguishes the English workman, and gives him his pre-eminence, is lacking in the French.'

Evidence of much the same character as regards other countries is easily found. In 1873 the English representative in Belgium reported thus: 'The flax and cotton industries have remained stationary during the past ten years. The two or three factory occupiers whom I met asserted that they could not pretend to compete with England. Manchester manufacturers, they said, could select their cotton on its arrival at Liverpool close to their mills. Coal was cheaper and handier at Manchester

than at Ghent. England, again, was the only producer of good machinery, and likewise possessed ready markets for her products in her vast colonial possessions. And lastly English operatives were far superior to Flemish. On this latter point all were agreed that the Englishman, being better fed, possesses greater physical power, and produces as much work in ten as the Fleming in twelve hours; and, having greater intelligence and mechanical knowledge, comprehends the machine he works, and can point out to the foreman, in case of obstruction, the cause of the accident, whereas in Ghent half an hour is constantly lost in seeking for the cause of a stoppage in the machinery.' The British representative in Switzerland reported in the like tone: 'The Swiss workman is in most respects inferior to the British workman. He has neither the physical strength nor the energy and activity of the latter. He is stolid in appearance, apathetic in temperament, slow and awkward in his movements, yet by no means wanting in intelligence. He is steady, methodical, industrious, and painstaking. Though of a saving disposition, no inducement in the shape of higher wages will stimulate him to extra exertion.'

Full inquiries were made in 1873 as to spinning and weaving abroad in view of the short-time Bill then before Parliament which became law the next year. Reports, from which we have quoted, were obtained from abroad, and Alexander Redgrave, the chief inspector of factories, accompanied by a sub-inspector, went on a tour of inspection through France and Belgium. After careful investigations they concluded thus: 'The value of the English

workman still remains pre-eminent, though the interval between him and his competitors is not so great as it was. He has not retrograded, but they have advanced, and that advance has been chiefly caused by manufacturers importing and copying from England that machinery which supplies the place of strength, steadiness, and perseverance. The Belgians are an industrious and painstaking race, but, with the French, they lack that intentness of purpose which is the characteristic of the Englishman. They are given to gossiping, their attention is not as close, they are moved and excited by more trifling causes than an Englishman.'

The Germans themselves have corroborated Mr. Redgrave's judgment. From the evidence given to the 'Reichsenquête für die Baumwoll- und Leinenindustrie' of 1878 it is apparent that the German cotton industry at its best was then very little in advance of England's in the 'thirties.' One example given showed the superior smartness of the English operative. A German millowner declared that Würtemburg spindles ran only 90 per cent. of the working time, while English spindles working 10 per cent. faster ran 95 per cent. of the working time.[1] In Germany, as a rule, probably more minutes were wasted; another millowner said that in England 92 to 95 per cent. of the full time was actively occupied, while only 80 per cent. could be filled in Alsace. And the same was true in weaving: in a case, which was put forward as not exceptional, 34 per cent. of the theoretical time was wasted; the

[1] *Protokolle*, pp. 81, 290. Quoted from Schulze-Gaevernitz's *Cotton Industry*, p. 89.

cause, remarked the witness, consisted in want of technical skill.[1]

These facts, however, are thirty years old, and time works wonders in an age of steam, telegraph, and newspapers. How do our German rivals stand to-day? Fortunately we are in a position to show in detail the relative state of affairs just twenty years after Alexander Redgrave and British representatives abroad made the reports from which we have quoted above, through the exhaustive investigations undertaken by the professor of political economy at Freiburg, Dr. G. von Schulze-Gaevernitz.

In one place Dr. Schulze-Gaevernitz speaks of the length of traverse and speed of the mule. Both he declares are as a rule greater in England than in Germany: these figures, according to him, give a picture of the conditions of production generally:—[2]

	Length of traverse[3]	In and out
Bolton (60's twist) . . .	66 inches	17·7 seconds
Alsace " . . .	60 "	22 "

The average number of operatives to 1,000 spindles in different places in 1891–2 he judged to be roughly as follows:—

England	3·0 (1887)
Switzerland	6·2
Russia	16·6
Mulhouse	5·8
Baden and Würtemburg	6·2
Bavaria	6·8
Saxony (new mills)	7·2
Vosges (old mills)	8·9

[1] *Protokolle*, p. 372 (p. 108 of Schulze-Gaevernitz's *Cotton Industry*).

[2] P. 88 of English translation.

[3] By the traverse of the mule is meant the distance travelled out by the mule-carriage when the yarn is being drawn out fine. The peculiarity of the spinning-mule is that it provides for the yarn being dragged out to

These figures are for 20's and 30's counts. Passing on to closer details, Dr. Schulze-Gaevernitz compares typical mills in Oldham and Mulhouse, and puts forward the following table as representative of the normal state of affairs :—

—	Oldham	Mulhouse
Number of spindles in mill	70,000	32,000
Hands employed mixing	2 men	2·3 men
„ employed loosening threads	4 men and women	7·6 men and women
„ employed carding	7 men	15·5 men
„ employed drawing	7 women	12·6 women
„ employed slubbing and roving	43 women and children	44·3 women and girls
„ employed spinning	95 men and boys	87 men and boys
„ employed as overseers	3	4
„ employed as packers	6	12
Total hands	167	185·3
Percentage per 1,000 spindles	2·4	5·8

These facts refer solely to self-actors. The operatives of England, Dr. Schulze-Gaevernitz concludes, exhibit an extraordinary capacity for work when compared with those of Germany. 'The self-actors in both countries are certainly on exactly the same principles; indeed, those in Germany have, in many cases, been made in England. Whilst in England about 2,000 spindles per pair of self-actors is to be looked upon as the usual number, about 1,300 to 1,600, with a great variation in some cases, are to be taken in Germany as the mean; 1,300 to 1,800 are given as the average in Mulhouse. In Germany this

a finer degree of tenuity, after the drawing of the yarn between the rollers, by the spindles moving away from the rollers and exerting a tension on the yarn while doing so. This moving away of the spindles is known as the traverse.

number of spindles is generally tended by more operatives than the greater number of spindles on the English machines. In Mulhouse 1,300 spindles require one spinner and four helpers (two piecers, two fillers); in England 2,000 spindles require only one spinner and two helpers; 2,000 spindles in one of the finest spinning concerns of Saxony require one spinner and four helpers, whereas in the smaller spinning mills of Saxony one spinner and five helpers are needed for a pair of self-actors with only 1,600 spindles.'[1] Moreover, the English spinner does not require the same amount of supervision as the German. In England one overlooker is needed for 60,000 to 80,000 spindles; in Germany as a rule one overlooker takes charge of about 15,000 spindles; in Saxony about 10,000, and in the smaller mills of the Saxon highlands only 3,000 or 4,000.[2] The table on the next page gives material from which conclusions may be drawn as to the efficiency of cotton spinning in England, Germany, and the Vosges in the case of different counts, chiefly of twist.

'Let us condense the results shortly,' says Dr. Schulze-Gaevernitz. 'In England the operative minds nearly double as much machinery as in Germany, the machines run quicker, the loss compared with the theoretical capacity is less. In the latter respect it is to be borne in mind that in England doffing and filling with bobbins takes place in a shorter time, breakings of ends occur more seldom, and the piecing of broken threads requires less time. From these it results that the cost of labour per lb. of yarn —especially if the overlooking is included—is in

[1] Schulze-Gaevernitz, p. 98. [2] *Ibid.*

Particulars respecting Spinning by Self actors. (From Schulze-Gaevernitz's 'Cotton Industry,' p. 108.)

—	Place	No of spindles per pair of self actors	No of operatives		Length of traverse	Secs for traverse backwards and forwards	Weekly working hours	Weekly production per pr of self actors	Spinning prices	Weekly earnings of spinners	Average weekly wages of helpers	No of spindles per overlooker	Weekly earnings of overlooker
			Spinners	Helper	Metres			Kilos	Pfennige per kilo	Marks	Mark		Marks
1 12's metric warp	Vosges	1,272	2	3	1 6	13	66	1,900	3 9	21	10 80	10,000 to 20,000	35 to 40
" "	Mulhouse	1,280	1	3	1 55	12 5	66	2,050	3 15	24	18 50	"	"
2 28's "	Vosges	1,272	2	2	1 6	15	86	900	8 89	21	10 80	"	"
" "	Mulhouse	1,280	1	3	1 55	14	66	740	7 02	24	18 50	"	"
					Inches English			lb	per lb				
3 20's twist English	Bavaria	1,568	1	3	04	15	65	2,420	1 9	18	10 70	15,000	27
" "	Wurtemburg	1,200	1	4	65	15	65	1,900	2 6	21	10 50	"	"
" "	Saxony	2,000	1	4	68	14	64	3,600	1 7	22	11	10,000	35
" "	Oldham	2,208	1	2	66	13	55	3,482	1 8	45	15 23	—	—
4 30's ,	South Germany	1,472	1	3	63 8	16	60	1,840	8 37	21	7 70	15,000	20 to 30
" ,	Bolton	2,064	1	2	64	14 6	55	2,200	8 25	40	12 75	—	—
5 36's "	South Germany	1,472	1	3	63 8	19	65	1,095	4	21	7 70	15,000	20 to 30
" ,	Switzerland	1,200	1	2	65	17	65	850	3·9	18	7 50	11,400	21 60
, ,	Saxony	1,704	1	3	65 2	15	85	1,550	8 35	21	8 to 18	5,000	20 to 25
		2,000	1	3	68	14	64	1,800	3 2	22	9 to 18	10,000	35
" ,	Oldham	2,876	1	2	67	13	55	2,182	8 25	38	17 75	—	—
		2,688	1	3	67	15	55	2,723	2 88	40 15	12 9	—	—
									Pence	s d	s d		
6 40's "	Oldham	1,560	1	2	65	13	55	1,223	0 6	38 5	14 2¼	—	—
" ,	Oldham	2,400	1	2	64	19	55	1,650	0 5	36 0	16 2	—	—
									Pfennige	Marks	Marks		
7 60's "	Alsace	1,248	1	2	60	22	69	590	9 75	21	12 50	12,000 to 15,000	28 50
" ,	Bolton	1,632	1	2	66	17 7	55	683	9 75	40	11	—	—
8 120's weft English	Alsace	1,764	1	3	65	28	69	258	22 75	21 60	10 83	8,000	28 50
" "	Bolton	2,280	1	3	59	21	55	333	22 28	43	11	—	—

England decidedly less than in Germany. The wages of the English spinner are nearly twice as high as in Germany, and the hours of labour a little over nine hours compared with eleven to eleven and a half in Germany.'[1]

Turning to recent figures we observe that in 1896 of 497 male operatives over sixteen engaged in cotton spinning in Baden, 134 received from 10*s.* to 12*s.* weekly, 116 received from 12*s.* to 15*s.*, and 105 received from 15*s.* to 18*s.*; only fifty-three were paid more than 18*s.*, and eighty-nine were employed at wages less than 10*s.* weekly.[2] Spinners' wages in England to-day are about twice as much. With these figures we may compare the results reached by Herr Hasbach, which are published in Schmoller's Jahrbuch.[3] Herr Hasbach reckons that the daily wages of spinners are about 5*s.* 10*d.* to 6*s.* at Oldham, 6*s.* 6*d.* at Bolton, and 5*s.* 6*d.* in Stalybridge and neighbouring places.[4] With these he contrasts the 3·70 to 3·80 marks paid in the Rhine Province and Leipzig, and the 3 to 3·15 marks paid in the Voigtland, Bavaria, and Alsace, and mentions an exceptionally high wage of 4⅔ marks which he found being earned by an operative who worked a new and long doubling mule. The wage paid to the big piecer in England, Dr. Hasbach goes on to show, is not much larger than that received by a good assistant in Germany.

[1] P. 104.

[2] Figures given in the *First Annual Abstract of Foreign Labour Statistics*, 1899, p. 18. They are compiled from *Jahresbericht der Grossherzoglich Badischen Fabrikinspection.*

[3] Vol. ii. 1903.

[4] These we believe to be under-estimates.

The figures given by Herr Hasbach for spinners' wages would lead one to suppose that the difference between the wages paid in spinning-mills here and in Germany must be greater than it actually is. In interpreting them we must remember that in England the spinner's wage is exceptionally high because the big piecer's wage is exceptionally low for an operative of his capacity. This state of affairs has been brought about by a variety of causes into which we cannot now enter;[1] but obviously, the facts being as they are, when a comparison is drawn between the wages paid for cotton spinning in different countries the averages of what is received by spinners and the first assistants should be contrasted, if not indeed the average wages paid throughout spinning-rooms since the systems of arranging labour of various qualities and machinery differ so widely. In England, moreover, the proportion of spindles to operatives is nearly twice as high as in Germany. According to Dr. Huber's figures[2] there are now about 106 spindles to an operative in Saxony. English spindles were reckoned as 44·9 millions in 1898 by Mr. Ellison, and for that year the factory inspectors returned the operatives engaged in spinning mills as about 212·5 thousand; England, therefore, has at least 211 spindles to one operative.

Let us consider next the comparative state of manufacturing, as weaving is generally termed. First arises the question of the speed of the looms, which in some cases in Lancashire had reached 240 picks per minute at the beginning of the 'nineties.'

[1] See an article in the *Economic Journal*, vol. x. p. 467.

[2] *Deutschland als Industriestaat*, p. 489.

From private information the following table relating to plain cotton goods was compiled by Dr. Schulze-Gaevernitz:—[1]

Picks per Minute.

Width	England	Switzerland	Alsace
80-85	240	190 200	150 160
110 115	200	160 170	130–140
135-140	180	150-160	120–125
165-170	180	120–130	110 115

Moreover, a larger percentage of the theoretical amount of work was attained in England than in Alsace or Switzerland. In England the average is three to four looms to a weaver; in Germany it is from two to three. From Dr. Huber's figures[2] it appears that there are about as many looms as hands in Saxony, whereas in England there were 615,700 looms in 1890 and some 314,500 hands engaged in weaving sheds in 1898,[3] that is, nearly two looms to each operative. For weaving in Baden of 118 males over sixteen examined only thirty-nine received weekly wages between 15*s.* and 18*s.*; thirty-five were paid between 12*s.* and 15*s.*; nineteen earned less than 12*s.*; and twenty-five earned over 18*s.* Of 722 women over sixteen years of age fifty-one were paid less than 8*s.* and eighty-three more than 15*s.*; of the remainder 125 received from 8*s.* to 10*s.*, 239 received from 10*s.* to 12*s.*, and 224 from 12*s.* to 15*s.*[4] Wages in England are considerably higher. Again, upon the question of wages in the cotton industries of Ger-

[1] Schulze-Gaevernitz, p. 107.
[2] *Deutschland als Industriestaat*, p. 489.
[3] *Factory Inspector's Returns.*
[4] *First Annual Abstract of Foreign Labour Statistics*, p. 18.

many and England we may quote Herr Hasbach.[1] Wages for weaving in Lancashire he places at 12*s.* to 24*s.* weekly. They vary according to the nature of the work, the number of looms to an operative, and in some slight degree (by 5 to 7 per cent.), Herr Hasbach declares, according to the sex of the operative. The average woman no doubt will usually turn out less work in a given time than the average man on the same number of looms. The inferiority of the average woman when doing exactly the same work as a man has, however, been denied; and it would be no easy task to establish the point beyond question; but at least, we should be inclined to argue, the average woman on the same kind of work as a man will earn lower wages because she will, as a rule, be controlling fewer looms. This, however, is a side issue which has drawn us from the main question. With the wages of 12*s.* to 24*s.* attributed by him to Lancashire, Herr Hasbach contrasts the average weekly wage of 9 to 10 marks paid to cotton weavers in Silesia, the 12 marks in Saxony, 13 to 15 in Holstein, and 15 to 16 in the Rhine Province and Alsace. One Silesian factory, he adds, from which he obtained information, paid on an average 10 to 15 marks to men and 8 to 12 marks to women.

Much has been made above of the fact that fewer hands are employed on a given quantity of machinery in England than on the Continent. It does not of course follow from this fact alone that British operatives of about the same rank are more efficient, since English employers as a whole might

[1] In Schmoller's *Jahrbuch*, vol. ii. 1903.

conceivably be pursuing the policy of saving on labour and spending on machinery, or the policy of employing a little high-class labour instead of much labour of average quality. But from the totality of the evidence advanced so far we may justifiably conclude that England still, of European and Asiatic countries at least, stands in advance in respect of the cotton industry. Dr. Schulze-Gaevernitz's figures, it is true, represent the state of affairs some dozen years ago, but we have been informed by him recently that no unusually pronounced changes have taken place in the intervening period, although the German industry has undoubtedly gained greatly in efficiency. The figures given, however, do not accurately represent the comparative efficiencies of German and English production, since Germany engages on the whole in a branch of the cotton industry in which more hands are needed in proportion to machinery, more time is wasted and less speed in execution can be acquired. In England the typical mills and factories in certain districts are given over almost entirely to the production of a narrow range of standard counts or a narrow range of standard fabrics. The problem to be solved by the industrial organiser—to discover the most economical arrangement of factors in production for the work in hand, and the most economical speed at which to work—remains the same in many of these factories from year to year, or changes but slowly, and, therefore, perfection tends to be brought about by the frequent small improvements that are constantly being introduced into a system which remains fundamentally unaltered. Moreover in such mills

the hands and machinery are specialised for a narrow range of work; and when repetition is frequent, hands and machinery can be 'speeded up' and wasted time can be cut down. Further, inasmuch as not only the cotton industry as a whole is highly centralised in England, but also its several specialised branches—for instance, fine spinning at Bolton and coarse spinning at Oldham—the environment of each factory (the labour market and the subsidiary industries) may be highly specialised. With an environment closely and specifically adapted to the requirements of the industry it is not astonishing that the typical English factory is progressively freeing itself from the waste due to slowness, clumsiness, and unsuitable arrangements. The German industry, on the other hand, is less centralised and less specialised. The range of work undertaken by the typical factory in Germany is far greater than that undertaken by the typical factory in England. Hence naturally the skill of the operatives is less in Germany; more time is wasted and factory organisation is less perfect. Moreover, because the German industry is more scattered, agricultural labourers are employed and run up the marginal cost of production, and good spinners and weavers are constantly returning to the land or entering other occupations. Factory operatives in Germany are not so much a class as in England—a class sifted by trial and trained from childhood. However, for small orders and special experimental designs, or designs for temporary and peculiar circumstances, the Germans hold a place in the world's market. Indeed, it is not altogether unusual for orders for new

classes of goods to be placed in Germany first, and for the new goods to be made ultimately in England in large quantities if they succeed in exciting an extensive demand. Moreover the strength of the German industry shows itself especially where it comes in contact with the chemical industry—for instance, in dyed and printed fabrics. Further, for thoughtfulness, enterprise, power to break new paths, and capacity to adapt themselves to new conditions, the German middle classes are becoming remarkable, and they do not neglect to make good use of education for industrial purposes. Hence arise Germany's exports in 1899 of 10,700,000*l.* worth of cotton manufactures and 2,289,000*l.* worth of cotton yarn, which explain in some degree why the spinners are as a whole protectionists while the manufacturers have marked leanings towards free trade. France, too, has a large export of cotton manufactures, 7,190,000*l.* in 1899, which is to be explained largely by the beauty and inexhaustible originality of French design.

There is no chance of the Continent rivalling England in the production of fine counts at present, since nowhere is the Continental climate sufficiently humid and no 'humidifiers' introduced so far have proved at the same time satisfactory and economical. Certainly one mill near Mülhausen contains a perfect humidifier, by which, instead of water being sprinkled, air is moistened and then blown into the factory; but its cost was so enormous that the owner of the mill gained by dispensing with it in later undertakings. Another disadvantage suffered by foreign spinners consists in the fact that large

quantities of raw cotton must, as a rule, be kept in stock by each mill, because the Bremen and Havre markets are not so perfectly organised as the Liverpool market, transport facilities are less developed in Germany than in England, and German business life has not yet advanced to the hand-to-mouth existence in the same degree as business life here. The Englishman tends to buy goods in small quantities as he needs them, and depends on prompt delivery by the railway companies, but the German must look further ahead and keep fairly large stores.

The efficiency of the hands in Alsace is unquestionably below that of Lancashire operatives. They go about their work in a more leisurely way. Doffing, for instance, is not done with that lightning rapidity which confounds the eye in Lancashire; the details of the operation can be followed easily; and, needless to say, the more rapidly the doffing is performed the greater is the product obtained from each machine. Alsace, with its factories running eleven and a half hours for five days in the week and on Saturdays from 6 A.M., the usual time for beginning work, until five at night, has undoubtedly a higher real cost of production than Lancashire with its week of fifty-five and a half hours. It is not unlikely, indeed, that the hours worked in Mülhausen are too long to yield the greatest continuous output.

The rapid extension of the continental cotton industry is largely due to protective tariffs, which have on the whole increased since about 1865; and the same may be said of the growth of the industry in the United States. When we contrast the ten years 1861–70 with the ten years 1892–1901 we

observe that the consumption of cotton increased 102·7 per cent. in Great Britain, but 282·3 per cent. on the Continent. No doubt one reason is the progressive specialisation of England in the production of the finer work. Thus we are prepared to find that our exports of yarn to the Continent, which had reached 108,385,000 lbs. in 1869, had fallen to 79,469,000 lbs. in 1900. In fabrics also our trade with the Continent shows the same decline. In 1869 the Continent received from us 353,918,000 yards and in 1900 only 284,858,000 yards; but the present exports are of a finer quality. To insure a correct interpretation of these figures it is needful to add that the values of our total exports of cotton goods in 1869 and 1900 were roughly the same, though money had appreciated in the mean time (*i.e.* prices had fallen), and to remind the reader of the calculation given in the first table of this chapter, which shows that when the values of our excesses of exports are reduced by index numbers to those of 1895 (*i.e.* when allowance is made for variations in the value of money) and expressed per head of population, the following results are reached: ·70*l.* in 1854, 1·27*l.* in 1873, 1·53*l.* in 1895, and 1·407*l.* in 1899. Yet our trade has not expanded in proportion to the growth of markets, and, while protection is unquestionably one reason, another is no doubt the comparatively late substitution of power-looms for hand-looms on the Continent. 'Thirty-five years ago,' writes Mr. Helm, 'the greater part of the cotton goods consumed on the Continent was either made in hand-looms or imported from England. Even now there are in Austria, as we were told in a consular report the

other day, 40,000 hand-looms weaving cotton cloth, and not more than 90,000 power-looms. In Russia an enormous number of hand-looms still exist, and in Germany and France there are some thousands of them. But in England the click of the cotton hand-loom had ceased entirely before 1870.'[1]

There can be no question that our most serious rivals in the cotton industry are the Americans. Their spindles numbered some 19½ millions in 1898 as compared with 45 millions in the United Kingdom, while of looms they possessed 453,281 in the same year—that is, between two-thirds and three-quarters of the number here. The Americans import more cotton goods than they export, but their efficiency is high and it has been steadily advancing in comparison with England's for the last fifty years. In 1840 it was asserted that England possessed an advantage in spinning over the United States of 19 per cent. in cost of production, which was neutralised, however, by cheaper cotton.[2] In 1878 the 'Economist' contrasted the results of twenty-five years' growth in England and America: 'In 1853 the average English production per weaver of 8¼ lb. shirting was 825 yards per week of sixty hours. In 1878 the working hours had fallen to fifty-seven, and the production had risen to 975 yards. An increased production of 23 per cent. is thus due to improvement in the processes of manufacture. In 1865 there were 24,151 persons employed in Massachusetts in the production of cotton goods, and they

[1] *Statist*, August 9, 1902.

[2] *The Cotton Manufacture of the United States Contrasted and Compared with that of Great Britain*, by James Montgomery, p. 219.

produced 175,000,000 yards. In 1875 the operatives numbered 60,176, and their product was 874,000,000 yards. The operatives had increased 150 per cent. and their products had increased 500 per cent. The increase of production due to improved methods was thus in England 23 per cent., and in Massachusetts 100 per cent. I do not, of course, suppose that the American manufacturer is in advance of his English rival to the extent of this difference, for I presume that he started upon the career of improvement from a lower platform. But a progress so greatly more rapid than ours will be admitted to cast much light on the change which has occurred in our relative positions.' [1] Certainly a very few years later, if not before, an American weaver was managing more looms than an English weaver; for example, of the women engaged in a shed at Lowell, Massachusetts, eleven had five looms a-piece, 232 had six, forty-three had seven, and twenty tended as many as eight; [2] and by 1890 it was commonly agreed that while the cost of spinning was lower in England, the cost of weaving most simple fabrics was lower in America, though the weekly earnings in America and England were roughly as three to two. Recently, in consequence of the sensational accounts as to the low cost of production in America, particularly in the Southern States, which were received in this country, a party of Lancashire manufacturers visited the United States in order to examine the actual state of affairs. Mr. Young, who accompanied this Com-

[1] On the state of the textile industry in U.S.A about this time see also J. P. Harris-Gastrell's Report to the British Parliament in 1873.

[2] Schulze-Gaevernitz, *Cotton Industry*, p. 109.

mission as a representative of the 'Manchester Guardian,' wrote an interesting book on his experiences, and from this we shall now proceed to quote extensively. It should be remarked that as Mr. Young was guided in his observations to some extent by practical men, his work possesses the greater authority.

During his tour through the cotton manufacturing districts of the United States, in the course of which he visited numerous factories, Mr. Young, who had previously visited factories in this country, was constantly attempting to gauge the comparative efficiencies of American and English workmen. After weighing all that he had seen and heard, he came to the conclusion that the typical American cotton operative is inferior to the English operative in energy, skill, dexterity, and watchfulness, which, Mr. Young submits, is not astonishing, at any rate in the case of the North, seeing that the operative there is oftener than not 'a French Canadian, a German, an Italian, an Hungarian, an Albanian, a Portuguese, a Russian, a Greek, or an Armenian.' In some American mills notices have to be printed in four languages. Successive waves of home and foreign labour have swept through the mills. English and Scottish displaced Americans, Irish displaced English and Scottish, and French-Canadians displaced the Irish when they became turbulent. Now the hands seem to be gathered from all quarters of the globe. And still there is constant change. As much as 5 per cent. of its workpeople will be lost weekly by even a good mill in New England. To anticipate, we may point out that herein is one reason

for high wages—namely, the mobility of labour in the American atmosphere, and its keenness in finding out the work which pays best.

Wages are indisputably higher in the United States than in England. In Massachusetts, for instance, the wages of the best hands would be somewhat as follows:—[1]

	s
Eight-loom weaver (plain)	45
" " (fancy)	50
Rovers	48
Ring-spinners	32
Drawers in	40
Warpers	38

These are very much higher than Lancashire wages for good hands, but in Lancashire there are no eight-loom weavers. The higher wages in the United States are not to be entirely explained by the higher prices there, and they do not appear to be occasioned by any very exceptional efficiency on the part of the workpeople. No doubt economical methods of production have fixed the real demand price for labour high, while the mobility and keenness of the average American workman has enabled him to secure something like the maximum wage which can be paid.

The splendid alertness and administrative skill of the American organiser is admitted on all sides. He is ready to take up inventions and stand risks, and as, should he be a paid manager, it is comparatively easy for him to secure a salary proportional to his value, his value tends to rise to the limits of his potential capacities. 'It is this which makes

[1] Young, p. 181. See also *Report on International Wages in* 1901, by the Bureau of Statistics at Washington.

America the inventor's paradise and keeps her industries in the van of technical progress, which explains partly why the principle of the warp-stop motion, invented in England three-quarters of a century ago; the idea of automatically renewing the supply of weft, which was hit upon by Rosseter forty years ago; the electrical warp-stop motion devised by a Bradford man; the famous automatic loom invented by James Northrop, of Keighley, and many other English inventions, have all been practically applied and developed and exploited in America.'[1] However, let us remember that all these inventions are of more value to the style of work done in America than to the usual products of the English industry. An example given by Mr. Young will serve to illustrate how cost is saved in America by a constant search for the best arrangement of factors in production, and how economy may be prevented, to the loss of both employers and employés, by a too rigid adherence to agreed piece-rates. 'Another interesting feature of the Merrimack mills was that there were thirty-five warping mills and only seven warpers. This contrasts sharply with the practice of a Lancashire mill which I had visited not long before, where the manager had tried the bold experiment of giving two warpers three mills between them instead of one each, and had abandoned it because, although the warpers earned better wages, they did not get the full production out of the machines. When I explained this to an American manager, he could not at first believe that the Englishman was not making a foolish mistake.

[1] Young, p. 186.

'"Why," he said, "don't they buy another frame, or two more, or as many as may be necessary to make up for the diminished output? The cost of a frame is only so much"—he named a figure—"and they would save as much in labour"—here he made a rapid calculation—"as would pay for the additional machinery in a very short time. And the warpers might still receive much higher wages."

'I reminded him that the price of labour in Lancashire cotton mills was regulated by a standard list which did not provide for variations in the piece rate according to the number of the machines run by the operative.'

'"Ah!" said he, "that accounts for it. Well, the sooner your employers and workpeople modify that list so that the employers may have some inducement to adopt machinery and methods which will diminish their cost of production, and at the same time enable the 'help' to carry home more money at the end of the week, the better for them."'[1]

The keenness and originative capacity of the American captains of industry have caused a steady advance to be made in the economies of production, and the American workman has secured his share of the gains thus occasioned. Even in industries in which no improved methods have been introduced wages have naturally tended to rise, and the employer has therefore been driven to economise his dear labour and devise labour-saving methods. That dash in economic affairs should be exhibited in a comparatively new country is not astonishing; and American

[1] Young, pp. 29-30.

energy has, in addition, been stimulated by a growing market. When the market grows rapidly and steadily an employer is constantly confronted with the idea of extending works, and in thinking of change he thinks naturally of possible improvements. Further, there is always room for new businesses, and new businesses sacrifice nothing by using the newest machinery and methods. In beginning business men seek naturally for the best plans and appliances procurable; it is only by habituation that apathy comes. Wherever the proportion of new businesses to old ones is large, the industry of which they are parts will tend to develope fast. The market for American textiles has grown faster than ours, for America has had, and in some degree still has, her home market to win, and in addition her international trade to develope. And her home demand has been expanding rapidly, partly through the natural increase of the American people, partly through immigration and the absorption of new country, and partly through increasing wealth.[1]

The apparent ease with which experiments can be conducted and changes made in factory organisa-

[1] *Population of the United States (Census years):*

1860	...	31,443,321	
1870	...	38,558,371 approximate percentage of increase	22·5
1880	..	50,155,783 ,, ,,	30
1890	...	62,622,250 ,, ,,	25
1900	...	76,085,794 ,, ,,	21·5

Population of the United Kingdom (Census years):

1861	...	29,321,288	
1871	...	31,845,379 approximate percentage of increase	8·5
1881	...	35,241,482 ,, ,,	10·5
1891	...	38,104,975 ,, ,,	8
1901	...	41,607,552 ,,	9

tion in the United States at once suggests that the employer there is less hampered than his English rival by interference on the part of his hands, and of this there seems to be little doubt. The American workman is readier to face new situations, and expects less permanence in the nature of his economic surroundings. If he is an immigrant this is comprehensible, for he is probably enterprising, and he has already made a change; and if he is an American he has lived in an atmosphere of change. As things move faster in a rapidly developing country, every American has learnt to take the ups and downs of life as normal, and the new experience is upon him before the old is forgotten. Therefore the thought of resisting or impeding advance is seldom so seriously entertained in America as in England; besides, the American cotton operatives are not so strongly combined as the English. And, in addition, there seems to be little doubt that the American workman's experience has not been of such a kind as to lead him to fear new conditions. An English workman finds it almost impossible to imagine that the adoption of labour-saving methods could result in higher wages and more employment; but the American knows that an increased demand for labour has followed the recent improvements in the cotton industry in his own country. Some 85,000 automatic looms have been set running in the United States in the last few years, and yet the demand for weavers and all cotton operatives is greater than ever, in spite of the fact that one man can manage about twenty Northrop looms or twelve Harrimans, and wages in the North Eastern States have risen fast.

In the cotton industry most American wages are now much higher than English wages. 'This is the right side of the water . . . better for making money,' a weaver who had emigrated from Darwen said to Mr. Young. The following figures relating to the United States as a whole, which have been extracted from the Twelfth Census, indicate some of the significant features of recent development :—

Cotton Goods (excluding Cotton Waste).

Year	Capital in million $	Wage earners (excluding salaried officials and clerks)	Total wages in million $	Value of product in million $
1880	220	185,500	45·6	211·0
1890	354	219,900	66·0	268·0
1900	467	302,800	86·7	339·2

It might be thought that the cost of production in the United States would be raised by the higher charges which must be incurred there under the head of fixed capital, but this does not appear to be the case. In spite of the fact that cotton machinery as a rule costs 50 to 60 per cent. more than in England—indeed, some English machinery, the 45 per cent. tariff notwithstanding, is to be met with in the United States[1]—a fully equipped mill costs little more than in England.

It is in the Southern States—in particular, North and South Carolina, Alabama, and Georgia—that the progress of the cotton industry in recent years has been most remarkable. In all the South in 1880 some 548,000 spindles only were to be be reckoned;

[1] The value of the machinery of all kinds and mill work sent from the United Kingdom to the United States was 803,000*l* in 1900 and 565,000*l* in 1901.

in 1898 the South could boast spindles numbering 3,500,000. The figures beneath show the distribution of the American cotton industry in 1898 and the relative positions of North and South :—

North.

	Spindles in 1898.	Looms in 1898.
Massachusetts	7,907,388	182,193
Rhode Island	2,182,850	40,085
New Hampshire	1,323,378	35,230
Connecticut	1,059,244	21,926
Maine	908,208	24,189
New York	735,971	15,474
Pennsylvania	488,435	18,990
New Jersey	398,494	2,300

South.

South Carolina	1,260,536	38,293
North Carolina	1,029,924	23,704
Georgia	799,977	18,504
Alabama	314,227	6,652

Since 1898, moreover, advance in the South has been surprisingly rapid. It is supposed that on January 1, 1902, Southern spindles amounted to 6¼ millions and Southern looms to 130,000. In the Southern States 663 factories could be numbered in 1900; in 1901 as many as 113 new mills were started, and it was said that 135 more would be running by the end of 1902.[1] As to the cause of this sudden development there appears to be considerable doubt. Probably one of the chief reasons is the nature of the American people. Changes in the United States are almost invariably characterised by their suddenness and magnitude; the American is quick and bold, and his mind is susceptible to the influence of big ideas. No doubt, as it has been

[1] Young, p. 118.

asserted, large financial operations are connected with this sudden expansion in the Southern States. Credit in the United States is buoyant: and in pushing their products Americans will take risks. It is said that 'machinists' are not altogether averse from receiving stock in payment or partial payment of machinery supplied to new undertakings for which it has been difficult to raise capital; in England too, we must notice, such an arrangement is by no means unknown. Probably the Draper Company has been so successful in pushing automatic looms through accepting in some cases payment or part payment in such a form. It might be easier to procure capital for a large company to work a patent and force it on to the market, than for a number of small businesses which intended to introduce the new appliances among much other machinery. By some it has been assumed that the cost of production in the South must be remarkably low, because the growth of the industry has been so rapid; but it is not altogether improbable that the rapidity of growth is in some degree attributable to the selling price having been kept low with a view to a market being secured.

Some of those who visited the Southern States are convinced that the labour cost there is, or has been, much lower than in the North. This seems not unlikely, since the new mills were established in a district whence much white labour could be drawn by an offer of very low wages. Numerous small farmers settled in the Southern States after the war, and to many members of their families even a small money wage was no slight attraction. Black

labour is not employed in the mills. Negroes will undertake carting and all open-air labour, and some will go so far as to feed the raw cotton into the bale-breakers, but none will face the full restraints of factory life.

An industry absorbs from the locality in which it is placed unsuspected supplies of disposable labour, and there is no cause for amazement when an American industry which has undergone rapid expansion and is ripe for further advance, instead of spreading in an exhausted labour market, settles in virgin fields. From the meagre evidence before us, it seems not unlikely that the money wage was low enough in the Southern States originally to bring the labour cost there below the labour cost elsewhere. But such a differential advantage cannot prove permanent. The efficiency of Southern labour is to-day admittedly lower than that of Northern labour, and already wages are rising and a dearth of labour is being experienced. The Southern manufacturer may have possessed an advantage in respect of labour cost at first, but to-day in many cases, according to Mr. Young, the labour cost is actually higher in the South though the wages are so much lower: probably the businesses which were the first to be established still enjoy a slight advantage because their labour is becoming more efficient. Moreover, the employment of young children, which led to grave abuses, is being checked; however, child labour never proves so economical as those who make use of it imagine, and it is doubtful whether in most cases it is economical at all, even to the generation which is callous enough to have recourse to it.

By some, Southern success in the cotton industry has been attributed almost entirely to the proximity of the mills to supplies of cotton; but the saving which most of them effect in respect of transportation is less substantial than one might at first be inclined to suppose. Much of the cotton which is in use now in the South is carried great distances, and the journey over water to the New England States, and even to Liverpool, is not costly. Moreover, against such gains as Southern mills reap in this respect must be set the inability to share in the facilities for obtaining cotton in small quantities and at short notice which are afforded to Northern and Lancashire mills by highly developed conditions of transport combined with advanced market organisation. While admitting such advantages as the Southern mills undoubtedly possess, we must not be blind to countervailing disadvantages and to the temporary character of some of the conditions from which they are now making a profit. They started, for instance, completely equipped with the newest machinery at a time when important new machinery was being introduced; as new concerns, with new machinery and new supplies of labour, which the managers could arrange in such forms as they wished without fear of much opposition from their employés, they were naturally run with a vigour and originality to which an old-established business in a long-settled industrial district is liable to become a stranger. They were, moreover, more specialised than the typical mills of New England. But they have yet to bear the brunt of interior renewals and alterations, and, therefore, to feel more than they do

to-day the want of the subsidiary industries with which New England factories are surrounded. The more we study the facts which have been brought to light, the more we feel convinced that no sensational industrial revolution can be predicted, and that in the Southern factories of the United States no special menace of a permanent character to the Lancashire cotton industry can be found.

While confessing that we have much to learn from American employers and workmen, we must not forget that the competition which is being felt by us in the East concerns only coarse goods, and that it was partly due to the relatively high freights at which British goods were shipped to Shanghai until more favourable terms were recently secured. In America itself there is actually to be found still a prejudice against the home-made fine cotton goods,[1] though, indeed, the average fineness of yarns spun in the United States has been rising. 'There are,' an American printer affirmed, 'as many faults in one yard of American cloth as in a whole piece of English. I have printed both.'[2] 'The product of the American system is a cloth which is, on the whole, distinctly inferior in appearance, "feel," and finish to that produced by the Lancashire system. To equal a Lancashire cloth in these respects an American cloth must not only be made of better cotton, but must contain more of it—perhaps 5 per cent. more. To this rule of inferiority there are, it is needless to say, exceptions—notably some of the American drills made for the China market. But the American home market, which absorbs nearly

[1] *Textile Recorder*, August 15, 1901. [2] Young, p. 125

the whole of the product of American looms, is less exacting in these matters than the markets in which Lancashire cloths are sold. The question for our manufacturers is: How far may American methods, with all that they imply, be profitably introduced into Lancashire?"[1] However, the elementary fact that commodities may be made too good for their purpose needs to be borne in mind.

The rapidity with which automatic looms have won their way into use in the United States is truly marvellous. At one possible cause we have already hinted; and the general cause is no doubt American enterprise. But, although we tend to hang back in the matter of making large experiments, the various new looms have been given trials in this country, and undoubtedly they are not so suitable for the bulk of our output and for our conditions as for American products and American conditions. Moreover, the economies of automatic looms even on cloths suited to them are not so great now as is supposed by many. The saving effected by Northrop looms at their present price has been placed at about one cent a pound on print cloth of which some seven yards go to the pound—that is threepence-halfpenny on fifty yards approximately; and this amount of saving has been challenged as much too high in some instances at least. But obviously the economies that arise are very difficult to estimate in general, since circumstances vary so greatly. However, automatic looms, of which there are now many different types in the market, will become more perfect and cheaper; to-day a Northrop loom costs

[1] Young, p. 13.

nearly three times as much as a fair loom of the old design.

Automatic looms, we ought to explain, are designed to feed themselves with weft to save the labour of inserting a new cop of weft when the old is used up, and to prevent the wasting of time. In some cases this end is achieved by a new shuttle automatically taking the place of the old one, and in others by a new weft cop being shot into the shuttle after the fragment of the old one has been discharged. The automatic feeding of the loom takes place in certain designs without a stoppage of work, but in other machines a momentary cessation of work is necessary. In some of the new looms a device is introduced by which the loom ceases to work when a warp breaks. This device is known as the warp-stop motion: as the one generally in use imposes some strain on the warp threads, it can only be applied when they are of a certain degree of strength, but recently an improvement has appeared by which the strain is greatly reduced.

CHAPTER VI

WOOLLEN, LINEN, SILK, AND HOSIERY INDUSTRIES

THE nature of the woollen industry varies so much in different countries that it is no simple task to draw international comparisons. The Continent of Europe uses qualities of wool which are little employed in England, and deals with them on machines which are not customary here. Only small quantities of River Plate wool, which is short of staple and requires special treatment because of the seeds with which it is mixed, reach England, nearly the whole of it being sold on the European mainland. We should expect to find, therefore, different wool-combing machines in general use in different countries: and we do actually find the square motion machine to be the favourite in France, the 'Noble' in England, and in Germany the 'Heilmann.' While River Plate wool proceeds in bulk to the Continent of Europe,[1] Australian and South African wool comes in bulk to England. Australia produces now, as a result of the importation of the merino sheep, the best wool in the world, while another English colony, South Africa, provides also wool of a quality superior to that obtained from any part of the Americas: the size, as well as the value, of an Australian fleece is far in excess of one from Argentina. In the United States the mass of

[1] Germany supplies only 25 per cent. of the wool used by her woollen industry.

the wool used which is not of home growth is imported from the River Plate.

The figures below as to the production and consumption of wool in Europe and North America have been supplied by Messrs. Helmuth, Schwartze & Co.:—

Production and Consumption of Wool in Europe and North America.

Raw Wool, in the State as Received.

	Production				Imports					Supply
—	United Kingdom (Fleece washed)	Continent. (Fleece washed)	North America*	Total Europe and North America	Australasian	Cape	River Plate	Other sorts	Total imports	Grand total
	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs
1891	148	450	320	918	592	102	330	179	1,203	2,121
1892	153	450	346	949	644	88	369	175	1,276	2,225
1893	151	450	361	962	632	91	360	164	1,247	2,209
1894	142	450	338	930	659	73	376	174	1,282	2,212
1895	135	450	307	892	730	84	439	197	1,450	2,342
1896	136	450	285	871	646	96	464	186	1,392	2,263
1897	139	450	272	861	660	83	496	204	1,443	2,304
1898	139	450	280	869	608	96	513	181	1,398	2,267
1899	140	450	285	875	593	92	520	181	1,386	2,261
1900	141	450	301	892	514	46	393	175	1,133	2,025
1901	138	450	316	904	600	73	532	143	1,348	2,252
1902	136	450	329	915	579	68	498	170	1,325	2,240

* Production of the United States and 13 million lbs. added for British North America.

Clean Wool, Estimated Yield after Washing.

—	United Kingdom	Continent	North America	Total Europe and North America	Australasian	Cape	River Plate	Other sorts	Total imports	Grand Total
	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs	Million lbs
1891	111	300	148	559	290	52	122	114	578	1,137
1892	115	300	154	569	315	47	140	113	615	1,184
1893	113	300	160	573	310	46	140	106	602	1,175
1894	106	300	149	555	323	38	150	113	624	1,179
1895	101	300	134	535	365	45	184	128	722	1,257
1896	102	300	124	526	329	49	195	122	695	1,221
1897	104	300	120	524	337	41	218	132	728	1,252
1898	104	300	121	525	310	45	226	119	700	1,225
1899	105	300	123	528	308	43	239	120	710	1,238
1900	106	300	127	533	272	21	187	112	592	1,125
1901	103	300	136	539	321	33	250	93	697	1,236
1902	102	300	147	549	310	37	232	112	691	1,240

The differences from year to year are to some extent due to delayed shipments.

For the United States, Germany, and the United Kingdom the following relation has been calculated between the imports, exports, and consumption. Discrepancies between this and the preceding table, where the two deal with the same facts, are to be explained by the selection of other estimates for the second table: —

Average Annual Quantities of Wool (not Cleaned) Produced &c. in the Last Five Years of the Nineteenth Century in the United States, the United Kingdom, and Germany.

	United States	United Kingdom	Germany
	Million lbs.	Million lbs.	Million lbs.
Produced	271·8	137·7	48·1
Imported	189·4	742·5	381·9
Total	461·2	880·2	430·0
Exported	9·2	358·4	21·3
Consumption	452·0	521·8	408·7

The United Kingdom to-day contains nearly three times as many sheep as Germany, the numbers being about 31,000,000 for the former country and some 11,000,000 for the latter. In 1873 Germany was said to possess as many as 25,000,000 sheep.

England produces a far less proportion of the woollen manufactures of the world than of the cotton manufactures, both of yarns and fabrics. The reason is, no doubt, that the woollen industry does not make such large claims upon technical ability and climatic conditions as the cotton industry. When a country develops, therefore, the woollen industry will be among the first to expand, and more particularly the branch of manufacturing. Hence it is not surprising that the number of power-looms in the United Kingdom

has actually declined. In 1870 they amounted to 115,484, in 1878 the number had reached 146,447, and by 1890 it had fallen to 131,506. The spinning business does not, however, show the same decline: the spindles, exclusive of doubling spindles, which have increased largely, were 4,486,000, 5,519,000, and 5,604,000 in 1870, 1878, and 1890 respectively. The total number of British spindles of all characters in the woollen industry in 1890 was 6,573,000; to-day there are more than 7,000,000.[1] And it must be remembered that the speed at which spindles and looms work has increased. These facts will prepare us for the figures below as to the import and export of woollen and worsted yarns and manufactures:—

United Kingdom. Woollen and Worsted Yarn.
In million pounds sterling.

Year	Exports	Imports	Excess of exports
1865	5·43	—	—
1866	4·74	—	—
1867	5·82	—	—
1868	6·20	1·65	4·55
1869	5·54	1·77	3·77
1875	5·10	1·47	3·63
1876	4·42	1·70	2·72
1877	3·61	1·73	1·88
1878	3·91	1·57	2·34
1879	3·71	1·40	2·31
1880	3·34	1·84	1·50
1881	3·23	1·35	1·88
1882	3·40	1·75	1·65
1893	4·53	1·74	2·79
1894	4·72	1·74	2·98
1895	5·37	2·04	3·33
1896	5·65	2·04	3·61
1897	4·84	1·77	3·07
1898	4·67	1·99	2·68
1899	4·88	2·20	2·68
1900	4·49	2·17	2·32

[1] The Home Office has not published figures for any year after 1890.

Of the imported yarns, the secretary of the Bradford Chamber writes that they are of a class which is 'either not spun in Bradford, or which it would not at present pay Bradford firms to spin.'[1] In addition to our export of yarns reference should be made to our growing trade in 'tops.' Tops are the long 'slivers' or loose ropes of combed wool upon which the spinner begins his operations. The annual average value of our exports of 'combed or carded wool and tops,' which stood at 611,000*l.* in the period 1890–3, amounted to about 1,534,000*l.* in the period 1897–1900.

United Kingdom. Woollen and Worsted Manufactures.

In million pounds sterling.

Year	Exports	Imports	Excess of exports
1865	20·10	1·70	18·40
1866	21·80	1·90	19·90
1867	20·12	2·30	17·82
1868	19·58	2·37	17·21
1869	22·67	2·53	20·14
1875	21·66	4·31	17·35
1876	18·60	4·92	13·68
1877	17·34	5·24	12·11
1878	16·73	5·93	10·80
1879	15·86	5·64	10·22
1880	17·27	7·65	9·61
1881	18·13	5·98	12·15
1882	18·77	5·98	12·79
1893	16·40	10·34	6·06
1894	14·01	9·73	4·28
1895	19·74	10·98	8·76
1896	18·27	10·66	7·61
1897	15·98	10·91	5·07
1898	13·70	9·82	3·88
1899	14·79	9·86	4·93
1900	15·68	9·19	6·49

[1] *British Industries*, edited by W. J. Ashley.

The diminution has been less in quantity than in value, since prices have fallen greatly, particularly those of manufactured goods, in the last thirty years. When these figures are compared with those for France, Germany, Belgium, and the United States, it becomes apparent that relatively the English industry has been declining.

Germany. Woollen and Worsted Manufactures.

Year	Exports*	Imports†	Excess of exports
1880	10·19	5·72	4·47
1881	10·83	5·25	5·58
1882	10·58	4·90	5·68
1893	9·77	6·48	3·29
1894	8·63	5·56	3·07
1895	10·50	6·44	4·06
1896	10·29	6·36	3·93
1897	10·02	5·43	4·59
1898	9·44	5·15	4·29
1899	10·64	6·28	4·36

* Exports 1893-1899 Woollen yarn and cloths and stuffs
† Imports " " " "
* Exports 1880-2 and 1888 " Woollen yarn and manufactures
† Imports " " " cloth, &c.

France. Woollen and Worsted Manufactures.

Year	Exports	Imports	Excess of exports
1865	12·96	1·52	11·44
1866	13·01	1·71	11·30
1867	10·70	1·68	9·02
1868	10·00	2·18	7·82
1869	11·84	2·57	9·27
1875	15·44	3·12	12·32
1876	13·80	3·16	10·64
1877	14·08	2·74	11·34
1878	14·00	2·75	11·25
1879	14·12	2·73	11·39
1880	16·78	3·16	13·62
1881	15·95	3·08	12·87
1882	17·67	3·37	14·30

France. *Woollen and Worsted Manufactures*—(continued).

Year	Exports	Imports	Excess of exports
1893	12·00	2·51	9·49
1894	10·43	1·74	8·69
1895	14·17	1·68	12·49
1896	12·95	1·80	11·15
1897	11·58	1·60	9·98
1898	10·09	1·53	8·56
1899	12·04	2·02	10·02

Belgium. *Woollen and Worsted Manufactures.*

Year	Exports	Imports	Excess of exports
1865	3·11	1·64	1·47
1866	2·66	0·62	2·04
1867	1·87	0·65	1·22
1868	2·15	0·69	1·46
1869	2·40	0·76	1·64
1875	3·58	1·07	2·51
1876	3·14	1·03	2·11
1877	3·32	0·92	2·40
1878	4·26	0·88	3·38
1879	3·57	0·77	2·80
1880	4·26	0·94	3·32
1881	4·21	0·91	3·30
1882	2·89	0·89	2·00
1893	2·88 *	0·97 *	1·91
1894	2·23 *	0·99 *	1·24
1895	2·67 *	1·02 *	1·65
1896	2·52 *	0·94 *	1·58
1897	2·15 *	0·87 *	1·28
1898	2·15 *	0·84 *	1·31
1899	2·62 *	0·89 *	1·73

* Except shawls.

United States. *Woollen and Worsted Manufactures.*†

Year	Exports	Imports	Excess of imports
1865	—	4·87	—
1866	—	11·96	—
1867	—	9·32	—

† 1893–99. Manufactures include carpets and carpeting, clothing ready made, cloths, dress goods (women's and children's), all other manufactures. 1879–1882 includes carpets, dress goods, cloths and other manufactures. 1875, carpets, dress goods, cloths and cashmeres, other manufactures. 1865–1869, carpets, worsteds and dress goods, other manufactures.

United States. Woollen and Worsted Manufactures—(continued).

Year	Exports	Imports	Excess of imports.
1868	—	6·23	—
1869	—	7·11	—
1875	—	9·29	—
1876	—	6·91	—
1877	—	5·21	—
1878	—	5·25	—
1879	—	5·07	—
1880	—	7·06	—
1881	—	6·49	—
1882	—	7·78	—
1893	0·07	7·93	7·86
1894	0·16	4·05	3·89
1895	0·14	8·03	7·89
1896	0·19	11·14	10·95
1897	0·20	10·24	10·04
1898	0·23	3·09	2·86
1899	0·22	2·88	2·66

The ups and downs in American imports are due chiefly to constant alterations in American tariffs. In 1890 import duties on woollen manufactures were, on the whole, raised considerably; by the reactionary tariff of 1894 they were lowered again, but only to be raised once more under the Act of 1897.

Germany has come rapidly to the front in the manufacture of woollens. Her spindles increased from 1·4 to 3·6 millions between 1861 and 1900. Still, however, Germany is much behind England, where the spindles number more than seven millions. As regards power-looms both countries are in much the same position; in 1890 the United Kingdom contained 131,506 in all her woollen, worsted, and shoddy factories. The United States must take lower rank in respect of the woollen industry, with power-

looms which numbered only 79,000 in 1898. In Germany many hand-looms are still to be seen, but they are diminishing in numbers. Germany's advancing industrialism is to be noticed also in the conspicuous growth which is taking place in the size of her factories as well as in the quantity of her machinery.

The circumstances of the industry in England and Germany being so unlike, little would be gained from contrasting the relative state of affairs in respect of the output per worker, the quantity of machinery managed by each hand, or the speed at which the machinery runs. And when comparing Germany's exports with England's we must bear in mind that the goods sent out from each country frequently serve different purposes. Flannels may be taken as one example. As a rule German flannels are thick and heavy, while English ones are comparatively fine and light, and the two sell at quite dissimilar prices. Sometimes the one class will be substituted for the other; as a market grows wealthier the finer goods will tend to displace the coarser. At the present time, for instance, Japan, which for years has offered an excellent market for heavy German goods, is showing an unmistakable preference for the lighter British flannels. Again vigogne—a yarn which is made from wool and cotton, or sometimes from cotton alone—is a specialty of Saxony, where some 600,000 vigogne spindles may be counted, among 850,000 cotton spindles, 350,000 carded yarn spindles, and 700,000 worsted spindles. Again, in parts of Germany a large number of fancy woollens are produced on hand-looms with which no English commodities compete directly. Of the

situation as a whole about a dozen years ago, Dr. Schulze-Gaevernitz wrote: 'In woollen and worsted both (the English and German industries) stand about equal; only the Huddersfield industry is superior in foreign competition.'

Although foreign countries are now producing so much for themselves, we need only refer to German critics to prove that in certain standard goods England has not yet lost her pre-eminence. As one example we shall quote now at some length from an article in the 'Monatsschrift für Textil-industrie' in 1898[1] by a well-informed writer. 'The fact cannot be denied,' says he, 'that the German clothes for male attire are inferior in quality and finish to particular English goods. German cheviots for the most part are not sufficiently flexible and glossy. The English merinos are finer and fuller than the German goods, and surpass them in consequence in softness and elasticity.' The difference the writer ascribed to the superiority of the British yarns; and the excellence of British yarns, he argued, is partly due to the fine English combing machinery, which differs in design from that employed in Saxony. In England more short hairs are combed out; in Germany the short hairs which are removed amount to about 5 to 7 per cent. of the wool treated, whereas in England they reach 20 to 30 per cent. of the total, and a finer. smoother yarn is the result. Hence the English can reach a tenuity in their yarns which the Germans are unable to approach. Moreover the former can spin softer; hence in England there is more chance of the right relation being attained between the

[1] P. 683.

hardness of the spinning and twining. The author emphasised this point in particular, and urged that a high quality in the yarn depends in a considerable degree upon the right conditions being observed between spinning and twining. Experiments in varieties of spinnings and twinings should be made, and the different kinds of yarn which are produced should be worked up in the same way to show the effects. The experiments would certainly prove costly but they would pay, and only by the adoption of such a plan could the perfection of English goods be approached. Again, the superiority of English cheviots, it is said, depends upon the preparation of the materials: the English cheviots have 'a full soft feel like Melton, whereas the German ones feel dry like paper. And the English cheviots possess the additional excellence of clinging to the body, and therefore they last longer than the stiff German cheviots, which after a little use become shiny and wear into holes.' There are, indeed, the writer continues, German cloths made from fine English yarns; but they are very expensive, and, since every effort is made to economise the material, they are seldom so good as English fabrics. Fine English cloths for male attire are thickly woven, but German ones made from fine English yarns are loosely woven, and frequently some inferior German yarn is worked up in them. As regards the finishing of cloths England again is pre-eminent. An important divergence exists between the English custom in the matter of finishing certain sorts of goods and the custom in many places in Germany. In England finishing is frequently effected by the manufacturer;

hence it is made to suit the various qualities of cloth which are produced. In Germany—except in Aachen—finishing is a separate business as a rule, and, as a result, the finishing is said to be scamped while little effort is made to adapt it to the nature of the goods under treatment. In Aachen, however, according to our informant, where the better qualities of cloth are produced and the custom which is frequently met with in England in the matter of finishing prevails, there is no reason why English perfection should not be rivalled. England, he concludes by observing, sets the fashion in clothing, but inasmuch as English colours are too 'bizarre' for the solid German taste, the home manufacturer has his opportunity.

The different customs which prevail in the matter of 'finishing' call for some explanation and comment. Although in stating the contrast noticed above we have expressed ourselves more guardedly than the article from which we quote, we are not sure that even now the distinction has not been represented as more emphatic than it actually is. However, for particular qualities of output there is no doubt a more marked tendency in this country than in Germany for excellence to be attained by the manufacturer supervising the finishing of his own cloth. The explanation of such a tendency—so far as it exists, for the distinct business of finishing is well established in Yorkshire—is in all probability somewhat as follows. When the manufacture of woollens for clothing is undeveloped, a general finishing industry yields results that are sufficiently satisfactory for all classes of goods, but when specialisation intensifies in manufacturing processes, the old lines of division

between industries become, in some cases, unsuitable. The new specialisation involves the maintenance of a close relation between spinning, weaving, and finishing for some goods, and a new division of businesses, therefore, is forced along the lines of demarcation between qualities of goods instead of those between processes. These facts should warn us against taking too mechanical a view of the operation of the tendencies which lead to division of labour among businesses, and guard us from assuming that the greater the appearance of external differentiation in an industry as a whole, the higher its stage of development.

That our German informant is not guilty of any serious exaggeration appears likely from the fact that the United States consul at Bradford, writing independently, lays stress upon the same points of excellence in English fabrics. The finish, says Mr. Day, the American consul referred to, has long been acknowledged as one of the strongest features in the textile trade of Bradford. Scarcely a week passes without continental goods being received in that town to be finished before being sold in English markets; and, adds Mr. Day, some of the foreign goods thus finished at Bradford are afterwards sold as of English make; and, needless to say, by this deceitful practice the high reputation of British goods is imperilled. For cotton fabrics as well as for woollen fabrics the Bradford finish is highly prized; hence "linings" from Bradford are regularly exported, even to the United States. It is encouraging to read Mr. Day's opinion that England, in respect of the Bradford trade at any rate, is not living merely on

her reputation; that, on the contrary, manufacturers, dyers, and finishers in the last two years of the nineteenth century showed themselves equal to the effort of taking that step in advance by which alone the retention of American markets was secured. Mr. Day, quoting an expert, asserts that the principal failing of American goods is to be found in 'finish'; they lack that 'soft clothing handle so peculiar to "Bradford products."' And this is the more remarkable since the Americans have worked with both English machinery and English hands. Bradford men attribute the difference partly to the lack of consideration in America as to the way in which the material and weave of the cloth will affect its capacity to receive a good finish. Again, it is said that in the finishing process in America fabrics are too roughly handled, too high a temperature is used, and the vitality of the wool is suppressed.[1] The fashion of wearing British cloths was recently said to be firmly rooted among certain classes in the United States, and dishonest American dealers in consequence have ticketed home-made goods as foreign to avoid the prejudice with which they would otherwise have to contend.[2] Our trade in clothing fabrics with the United States to-day, however, is not of much value; the average annual value of our exports thither of all woollen and worsted domestic manufactures for the period 1897–1901 was 112,000*l.* only.

Altogether the woollen industry of the United States is behind that of England. In America there

[1] Mr. Day's report will be found printed in the *Textile Recorder* for April 14, 1900.

[2] Report on the woollen industry for the Eleventh Census in the United States.

is less specialisation; but there is said to be a well-defined tendency in the United States at the present time in the direction of the English system. With regard to the efficiency of the operatives in the two countries statistics cannot provide us with any trustworthy indications. The English yarns are of finer counts on the whole than the American; more carpets are made in the United States; and, lastly, about half the English spindles are worsted spindles, whereas only about a quarter of those in the United States produce worsted, and woollen spindles use up much more material than worsted spindles.

From the tables below, which are taken from the Twelfth Census, the recent movements in America may be read:—

—	Capital in million $	Wage earners (excluding salaried officials and clerks)	Total wages paid in million $	Value of product in million $
Woollen goods				
1880	96·1	86,500	25·8	160·6
1890	131·0	76,900	26·1	133·6
1900	124·4	68,900	24·8	118·4
Worsted goods				
1880	20·4	18,800	5·7	33·5
1890	68·1	43,000	14·9	79·2
1900	132·2	57,000	20·1	120·3

English wages stand between those of America, which are higher, and those of Germany, which are lower. The difference, however, is less in the woollen industry than in the cotton industry in the case of England and Germany, and the reason is no doubt that it is in the cotton industry that English pre-eminence is so strongly marked. A comparison of woollen weavers' wages in the two countries is by no means easy, since in England the industry has

differentiated much more than in Germany, and the differentiated branches have localised separately. According to Mr. Bowley, the average weekly wages of men and women woollen weavers in Bradford varied from 12*s.* to 18*s.* in 1901, while in Leeds they stood at 26*s.* for men and 13*s.* for women, in Huddersfield at 26*s.* for men and 13*s.* to 17*s.* for women, and in Batley and Dewsbury at 15*s.* for men and 13*s.* 6*d.* for women. With these averages Herr Hasbach[1] contrasts some German wages. For Schleswig-Holstein the average weekly wages reached 17 to 20 marks between maximum wages of 28 marks and minimum wages of 12 to 13 marks. The master of a Rhenish factory informed Herr Hasbach that in his business the average daily wages of male weavers amounted to 3·60 marks in 1902, when the wages paid to those of advanced years, whose efficiency was below the average, were included. The highest wages of the district were earned in this factory; the lowest wages paid there during the preceding twenty-five years had been 2·88 marks in 1879, and the highest wages had been 3·65 in 1901.

The comparisons made by Herr Hasbach certainly show that the German woollen weaver is not badly off when his position is compared with that of his English rival. And the same may be said of the relative conditions of German and English spinners. Mr. Bowley gives as the average daily wages of spinners 5*s.* in Leeds and 4*s.* in Batley and Dewsbury; while Herr Hasbach reckons 4 marks for the Rhein province and 3·70 marks for the Voigtland, Bavaria, and Alsace. With these con-

[1] In Schmoller's *Jahrbuch*, vol. ii. 1903.

trast the following average weekly wages for woollen workers in Massachusetts in 1897: weavers, 36*s.*; spinners, 45*s.* 5*d.*; spinners (boys), 30*s.* 9*d.*; spinners (women), 26*s.* 7*d.*

This comparison of nominal wages, we must remind the reader again, is rough in character, because differences in the kinds of work done have had to be ignored; moreover, the averages are rough averages in the calculation of which allowance has not been made, at any rate in most cases, for the numbers of people earning each particular wage. As regards comparison with American conditions we cannot conclude without quoting the results of an investigation made by Mr. Carroll D. Wright more than ten years ago. 'The income per family from all sources in the woollen industry, 911 families in America being considered, was $663·13, while in Europe, for 334 families, it was $449·58. The total expenditure for all purposes for the American families was $594·09, and for the European families $414·73. Five hundred and eighty-three American families had saved during the year, on an average, $136·16, while 268 families experienced a deficit of $61·49 each on the average. Two hundred and nineteen of the European families saved $67·67 each, and seventy-two show a deficit of $44·16.'[1] Thus Mr. Carroll D. Wright proves that at the time when he wrote the American wool-worker enjoyed an advantage, in respect of the difference between wages and the cost of living up to the standard of comfort, as roughly estimated by him, over European wool-workers of barely 3·2 per cent.

[1] Quoted from the *Report on Wool and Manufactures* (Bureau of Statistics, Washington), p. 11.

The American could save 11·6 per cent. and the European 8·4 per cent. of his income.

Linen

Turning to the linen industry, we notice that the distribution of spindles and looms in Europe was reckoned to be as follows in 1898 :—[1]

	Spindles	Power-looms	Hand-looms
Great Britain	1,600,000	60,000	a few only
France	550,000	17,000	20,000
Germany	360,000	17,000	75,000
Austria-Hungary	350,000	4,500	60,000
Belgium	250,000	4,000	—
Russia	240,000	8,500	45,000
The rest of Europe	150,000	10,100	—

* These figures are, we feel sure, over-estimates. There were only 1,193,000 spindles for spinning and doubling in the United Kingdom in 1890, and the numbers were then decreasing. Compare also the figures for foreign countries which are quoted below. Possibly the spindles for hemp and jute are included in Brockhaus's figures.

In the linen industry of the United Kingdom the number of spindles has declined while the number of power-looms has advanced; but it must be remembered that spindles now revolve much more rapidly than they did formerly, so that an increased output may be achieved with a diminished number of spindles. Flax spindles, exclusive of doubling spindles, in the United Kingdom fell steadily from nearly 1,500,000 in 1870 to 1,135,000 in 1890,[2] and in the same period power-looms rose from 35,300 to 48,700. The increase in power-looms means in some degree the displacement of hand-looms, but as the advance has been continuous up to the present time it implies also that the industry is expanding in a greater ratio than the increase in the speed at which machinery works. In

[1] Brockhaus, *Konversations-Lexikon.*

[2] The Home Office has published no figures for any year after 1890.

seeking explanations for the history of our linen industry in the past few years, we must notice, in addition to the advance of backward countries, that improvements in cotton fabrics are constantly bringing about their substitution for linens: hence the world's production of flax fell from nearly 615,000,000 kilograms in the early 'eighties' to some 525,000,000 kilograms about 1890. This general and striking decline in the demand for linen must be borne in mind when meanings are being assigned to the figures relating to the industry and trade in linen of different countries.

The British linen industry, like the British cotton industry, is highly centralised. For a long time past the chief seat of the industry has been Belfast, and, according to an interesting paper read to the British Association at Belfast in 1902, by Sir R. Lloyd Patterson, the relative size of the Irish industry, in comparison with the linen manufacturing carried on in other parts of the British Isles, has steadily increased. Cotton drove linen out of Lancashire, as linen drove cotton out of Belfast; or, expressed in another way, the economies possessed by the centralised industries gradually destroyed the decentralised businesses. A linen mill in Lancashire suffered in two ways: on the one hand it found the best of Lancashire labour absorbed by the cotton industry, which through the economies of centralisation could offer higher wages; and on the other hand it found its product being undersold by the cheaper products of the centralised Irish industry. From Cumberland, Yorkshire, and other parts of England, as well as from Lancashire, the linen manufacture has been gradually forced until few firms remain to-day. But

in Ireland the relative growth of the industry has been accompanied by an actual decline in the number of spindles.

Flax Spindles in Ireland.

In 1841	there were returned	250,000	spindles.	
„ 1850	„ „ „	326,008	„	
„ 1861	„ „ „	592,981	„	
„ 1871	„ „ „	866,482	„	
„ 1875	the maximum of	924,817	„	was reached.
„ 1881	there were returned	879,242	„	
„ 1891	„ „ „	827,451	„	
„ 1901	„ „ „	836,146	„	

With this table Sir R. Lloyd Patterson[1] contrasts the following calculations as to the state of affairs in other countries:—

In Germany and Austria the maximum was reached in 1874 with	741,214	spindles.
By 1901 this number was reduced to . .	573,210	„
A diminution in 27 years of	168,004	„
In Belgium the maximum of . . . . . was reached, also in 1874.	320,000	„
By 1900 the number had fallen to . . .	287,580	„
A diminution of	32,420	„
In France the maximum of . . . . . was reached earlier, in 1867.	750,000	„
The year 1874, which was the highest in the other continental countries mentioned, already showed a considerable decline in France. This went on continuously till in 1902 the number had fallen to . .	448,426	„
A diminution of	301,574	„

Thus a 9 per cent. decrease in Ireland in twenty-five years is confronted with decreases of some 40 per cent. in France, 22 per cent. in Germany and

[1] In the paper above referred to. This paper in an expanded form was delivered as a lecture in the Faculty of Commerce in the University of Birmingham, and is reprinted in a volume entitled *British Industries*, edited by Professor Ashley.

Austria, and 10 per cent. in Belgium. But the Irish industry, we must remember, has absorbed the English industry: the total number of flax spindles (exclusive of doubling spindles) in the United Kingdom declined about 23½ per cent. between 1870 and 1890. The cause of this general diminution of spindles has already been noticed: it is partly the remarkable substitution of cottons for linens, partly the greater productivity of each spindle, partly the spread of the manufacture into regions which were but slightly developed until recently. Italy, for instance, has now some 65,000 flax spindles running, while Russia, with the aid of high tariffs, has raised the number of her flax spindles in thirty years from 83,000 to over 300,000.

The decline in spindles has been accompanied by an advance in power-looms. In Ireland the numbers have been:—

1871	14,834
1881	21,779
1890	26,592
1899	32,245

Compare the increase between 1871 and 1890 with that for the United Kingdom as a whole in the same period—namely, 35,300 to 48,700—which is much less, as we should naturally expect.

In England and Ireland hand-looms, though not quite extinct, as in the manufacture of cotton, are very scarce; yet many still survive, it will be observed, on the Continent, noticeably in Germany, although, with France and Belgium, the Empire stands in advance industrially of all other continental countries.

The chief flax-growing country is Russia, which produces about two-thirds of the world's yield. Russian trade in this material has grown largely of late years, partly because of the development of Russian railways, and partly because the substitution of cotton for linen in Russian consumption rendered it essential that a larger proportion of the crop of flax should be exported. Germany now raises herself only about 20 per cent. of the raw material required for her linen industry; the mass of the remainder is imported from Russia. The United Kingdom has fallen behind also in the production of flax, as witness the following figures :—

Acres under Flax.

—	1880	1885	1889	1890	1891	1902
Ireland . .	157,584	108,149	113,817	96,871	74,672	49,742
Great Britain	8,985	2,490	2,375	2,455	1,801	835

In respect of the preparation of the flax no place has yet succeeded in rivalling Courtrai, in Belgium, where some peculiar property in the waters of the Lys, which does not exist throughout the entire length of the river, imparts a high quality to the flax retted in it. The nature of this property has not yet been accurately determined, but scientists—particularly Russians, for the Russians are deeply interested in the matter in consequence of their enormous crops of flax—are engaged in investigating it. So great is the demand for Courtrai flax that crops gathered from the district have proved insufficient to meet it, and flax is now regularly imported from other countries to supplement the

local supply. The flax trade of Courtrai, we may notice with some satisfaction, is almost entirely in the hands of English and Irish firms, for little spinning and weaving is done there, and what manufacturing does exist is largely conducted upon hand-looms; indeed, more hand-loom factories than power-loom factories are to be counted in Courtrai.[1]

In spinning Germany has lost the relative position which it once held. Formerly much yarn was exported, but now only about 5 per cent. of the produce of German spindles is sent abroad, and this proceeds chiefly to Austria, Spain, Switzerland, Denmark, and Sweden. Recently the exports have increased slightly: they stood in millions of pounds sterling at ·09, ·095, ·095, ·11, ·105, ·11, ·14, in each of the years from 1894 to 1900. At present the Germans import about 27 per cent. of the linen yarn used by them. According to a recent German writer[2] the changed state of affairs is due to the introduction of spinning by power. The spinners of Germany could once undersell most competitors; now they are unable to hold their own against such continental neighbours as Austria and Italy, partly, it is said, because of the lowness of the wages in those countries. And Ireland, writes Dr. Heinz Potthoff-Bielefeld, stands ahead 'because of the specialisation there which enables each factory to confine itself to a few sorts only, and to bring them to the highest perfection at a low cost.' The specialisation in the linen industry of Belfast, nevertheless, is nothing

[1] *Reports, &c.* 1900, xci. p. 24.

[2] Dr. Heinz Potthoff-Bielefeld, in a volume, *Die Leinen- und Wäsche-Industrie*, written for the Handelsvertragsverein.

in comparison with that of the cotton industry of Lancashire. Coarse linen yarns are now imported into Germany in bulk from Bohemia; but fine yarn is procured from Ireland and Belgium, and the finest exclusively from Ireland. The hope of establishing fine spinning in Germany by the imposition of stringent protective duties has not yet been realised. The German producers of yarn, it is said by Dr. Heinz Potthoff-Bielefeld, have been handicapped by the high import duty on spinning machinery, which comes chiefly from English works, though Germans have tried to rival them. As to fabrics, the Germans export more than they import: probably about 11 or 12 per cent. of their produce is exported. Their best customer is the United States. For damask, Great Britain offers a good market, and Denmark, Sweden, and Switzerland are also important buyers of German linen.

From the two following tables the recent movements in the German foreign trade in linens may be read. It will be seen that, taking the five-yearly averages up to 1899, the value of the excess of imports of yarn has diminished though the tonnage has increased. With this compare the slightly different results shown in the excesses of exports of fabrics. The figures for the trade in fabrics, it should be noticed, contain those for the re-importation of the German goods which are sent to Ireland to be bleached. Considerable quantities of linen pass from Belgium, France, and Germany to Ulster to be bleached, on account of the excellence of Irish bleaching.

Average Annual Foreign Trade of Germany in Linen Yarn, including since 1896 *Yarns over* 20's *(English Classification) made from Jute or Manila Hemp, but excluding Sewing thread and the Yarns therefor, in Pounds Sterling and Tons of* 1,000 *Kilograms.*

—	1886–90 Tons	1886–90 Mill £	1891–95 Tons	1891–95 Mill £	1896–99 Tons	1896–99 Mill £	1900 Tons	1900 Mill £
Imports .	10,870	·985	10,416	·895	11,738	·88	12,568	·985
Exports .	1,178	·11	1,135	·095	1,872	·105	1,437	·14
Excess of imports .	9,692	·825	9,281	·8	10,866	·725	11,131	·845

Average Annual Imports and Exports of Germany in Linen Fabrics, including those partly made of Linen and including also after 1896 *certain Finer Goods made of Jute and Manila Hemp, in Pounds Sterling and Tons of* 1,000 *Kilograms.*

—	1886–90 Tons	1886–90 Mill £	1891–95 Tons	1891–95 Mill £	1896–99 Tons	1896–99 Mill £	1900 Tons	1900 Mill £
Linen cloth, linen ticking, and drills (Leinwand, Leinenzwilich und Drillich):								
Imports	875	19	663	22	804	·28	725	·8
Exports	2,323	43	1,968	415	2,216	·405	2,535	475
Excess of exports . .	1,448	24	1,305	195	1,412	·125	1,810	·175
Damask of all kinds:								
Imports	14	·005	15	01	16	·01	15	·01
Exports	495	18	523	205	341	·105	311	85
Excess of exports . .	481	·175	508	·195	825	·95	296	·75
Tablelinen, bed linen (made up), and towels (Tisch, Bettzeug verarbeitetes, Handtucher) .								
Imports	2		2	—	2	—	1	—
Exports	268	·75	611	·15	552	·14	862	·21
Excess of exports . .	266	75	609	15	550	·14	861	·21
Total excess of exports . .	2,195	·49	2,422	54	2,287	36	2,967	·46

* In these figures the re-imports of linen sent to Ireland to be bleached are included

United Kingdom. Linen Yarn

—	1886–90 Million £	1891–95 Million £	1896–99 Million £	1900 Million £
Imports	·644	·786	·752	·915
Exports	·895	·940	·953	·934
Excess of exports .	·251	·154	·201	·019

The average annual exports of linen yarn had been previously as follows :—

1854–58	1859–63	1864–68	1876–80
1·327	1·896	2·532	1·201

United Kingdom. Linen Manufactures.

	1886–90	1891–95	1896–99	1900
	Million £	Million £	Million £	Million £
Imports	·893	·392	·369	·590
Exports	5·550	4·965	4·817	5·224
Excess of exports .	5·157	4·573	4·448	4·634

* Exports of linen manufactures include white or plain, printed, checked, or dyed, sailcloth and sails, thread for sewing, other sorts.

The exports of linen manufactures had been in earlier periods :—

1854–58	1859–63	1864–68	1876–80
4·35	4·98	8·287	5·659

Silk

Next we may glance at our silk trade. A severe blow was administered to it by the Cobden-Chevalier treaty, which allowed free play to the competition of France. Thus our exports of home-made silks, which were valued at about 1½ million pounds sterling at the time of the treaty, stand at the same figure to-day, while the imports have advanced from an average of 2 million pounds sterling before 1860 to 6 millions in 1861, over 9 millions in 1866, nearly 11 millions in 1868, and to an amount averaging almost 16 million pounds sterling in the last five years of the nineteenth century. As the silk industry here is insignificant in size in comparison with that abroad, we may learn without surprise that in respect

of general efficiency England is far from leading. We are in the world's silk industry what Alsace is in the world's cotton industry; but the kind of work done here serves its purpose. Our inferiority becomes especially noticeable when a comparison is drawn between our businesses as a whole and the highly centralised silk industry of Lyons. In Lyons specialism is more advanced, and operations are conducted on a more magnificent scale. However, the French silk trade has not expanded with the growth of markets: the silk industry of Lyons, like the cotton industry of Lancashire, is feeling the effects of facing the developing industrialism of other countries.

Manufactures of Silk exported from France.

Year	Value	Year	Value
	Million £		Million £
1861	13·33	1881	9·80
1862	14·54	1882	11·58
1863	14·81	1883	12·05
1864	16·83	1884	9·47
1865	17·14	1885	8·88
1866	18·71	1886	9·68
1867	16·92	1887	8·89
1868	18·08	1888	8·93
1869	17·90	1889	10·43
1870	19·40	1890	10·96
1871	19·86	1891	9·81
1872	—	1892	9·97
1873	19·14	1893	9·28
1874	16·65	1894	8·94
1875	15·07	1895	10·83
1876	11·84	1896	9·88
1877	10·37	1897	10·88
1878	10·12	1898	10·02
1879	9·07	1899	11·15
1880	9·37	1900	—

In recent years Italy and the United States have been coming to the front while Germany has declined, and the cultivation of the silk worm in France has

not increased in spite of the Government bounty.[1] In forty years the United States has raised the proportion of the home-made silk goods in use at home from 15 to 85 per cent. of the total consumption, and the advance made in the last twenty years may be gathered from the table annexed:—

Silk and Silk Goods

—	Capital in Million $	Wage earners (excluding clerks and salaried officials)	Total wages paid in million $	Value of product in million $
1880	18·1	31,337	9·1	41·0
1890	51·0	49,382	17·8	87·3
1900	81·1	65,416	21·0	107·3

This, however, merely proves the effectiveness of tariffs in diverting industries, and not the superior efficiency of the Americans. We can hardly believe that wonders have been wrought in the American nature in the last few years; for a short time ago Mr. Schoenhof, contrasting the French and American industries, arrived at results by no means favourable to his own countrymen. 'Science, art, individual skill, leadership of no common sort, must combine in silk manufacture to carry it through to success. The dyeing, the weaving, the designing, the selection of colours, the finishing, all become matters of greatest importance. Skill and taste in all these are essential to success. In Lyons, in a specimen of work intended for the Paris Exposition of 1889, I found that every part was executed by the manufacturer himself, who happened to be the

[1] See, *e.g.*, report of the United States Consul at Lyons on the silk industry in 1902, and the report of the United States Consul at Rouen in 1901.

President of the Lyons Silk Manufacturers' Association. He would entrust no part to anyone else. In Lyons everyone concerned puts a certain amount of feeling into the work. In the United States everybody concerned is bent on but one end—to grind out the greatest possible quantity in a given time.' High tariffs can always compel people to buy inferior articles, but they cannot always produce efficient industries. And France, we are told, has moved some of its works into the United States, so that the 85 per cent. is not all, in the full sense, the outcome of a native industry. Switzerland too has been driven by the heavy duties imposed on her silk goods into the policy of establishing works abroad, with the result that there are now twenty-three Swiss silk factories outside Switzerland—3,652 looms in Swiss businesses in Germany, 1,445 in France, 1,401 in Italy, and 2,058 in America. None of these firms is in England, since we take Swiss silk goods freely; as much as 40 per cent. of the Swiss silk exports finds its way to these shores.

Hosiery

Lastly, under the heading of textiles, we shall notice hosiery. 'It is not difficult to create a hosiery industry in any country for the cheaper quality of goods,' said Mr. Harris, an American Consul, in his report on German textiles in 1901, 'provided labour can be had at reasonable rates. Such is the case in Italy, Spain, and Bohemia. These countries, which formerly drew large quantities of hosiery from Germany, have completely emancipated themselves, so far as supplying their own consumption is con-

cerned, and are now competing in foreign markets with German goods.'

About 100,000 people are said to be employed in the German Empire manufacturing hosiery, whereas the numbers employed in hosiery factories in the United Kingdom are no more than 36,000. However, there is little doubt that these figures are not comparable; those for Germany probably include many kinds of people who are not included in our figures for factories only. In 1870 less than 10,000 hands were working in British hosiery factories; but the increase of 260 per cent. in the last thirty years no doubt tells the tale of the triumph of the factory system in this industry more than of a phenomenal growth in the numbers of our customers or their needs. This hypothesis might be tested by examining the figures for imports and exports, but it would prove a laborious task to pick out such goods as should be classed as hosiery. The exports of woollen hosiery, however, which were valued at less than half a million in the early 'eighties,' are worth between three-quarters of a million and a million to-day.

Of the German exports of hosiery, the largest proportion proceeds to the United States; but in the United States itself more machine-knit goods are produced annually than in all other countries taken together, according to a statement made in the report on manufactures for the Twelfth Census. Recently in the United States a strong demand has been felt for embroidered hosiery, and it is said that the work of embroidery is far more expensive in the United Kingdom than in Germany, where it is done by women and children, particularly in the mining districts, for

a wage which rarely exceeds *5s.* a week. For certain classes of hosiery the American market has been lost, owing largely to the American tariff; but the German manufacturers have followed up their defeat by establishing businesses in the United States.[1] Norway and Sweden manufacture for themselves, but on machines imported largely from Germany. In Russia foreign hosiery is almost prohibited by high tariffs, but the Chemnitz manufacturers have met the situation by establishing branch factories there. In South America, India, and China, according to Mr. Harris, German hosiery is just able to hold its own against Italian and English competition. In Germany the hosiery industry is located chiefly in Saxony, and the bulk of the machinery is supplied by Chemnitz.

[1] Upon the above see Embassy Report of 1902 on the Trade of Chemnitz.

CHAPTER VII

CHEMICALS AND DYES

A SERIOUS difficulty confronts us when we attempt to compare the trades in chemicals of different countries —namely, that the term 'chemicals' is extremely vague as to its denotation, and international agreements have not been arrived at as to the classifications to be adopted. Hence figures may lead to the most mistaken conclusions. Mr. Evershed's paper, therefore, on the 'Statistics of chemical imports and exports of the United Kingdom and Germany in the year 1901,'[1] is of considerable value, particularly as Germany is by far the largest exporter of the heterogeneous class of goods which is covered by the term 'chemicals,' of all the nations of the world; France exports only about half as much as England, and the United States little more than half as much as France, according to each country's own definition of 'chemicals.'

The exports and imports in German 'special' trade (which excludes the mass of the transit trade, though not quite the whole of it) were in detail as follows in 1901:—

[1] *Journal of the Society of Chemical Industry*, April 1903.

GERMAN EMPIRE.

Imports and Exports, 1901. *'Special' Trade. Chemical Industry and Pharmacy, Manufactured Products.*

Principal Articles	Imports, 1,000*l.*	Exports, 1,000*l.*
(*a*) *Imports exceeding Exports.*		
Iodine	289	26
Ammonia sulphate	489	108
Ammonia carbonate and hydrate	82	79
Chlorates of potash and soda	56	21
Acetate of lime	186	0
Calcium carbide	107	8
Pitch	134	23
Tar	84	75
Naphthalene	69	11
Light coal tar oils	116	40
Wood spirit	184	59
Ethereal oils	259	233
Turpentine, other resin oils and camphor oil	715	49
Dyewood extracts	97	35
Catechu	134	18
(*b*) *Exports exceeding Imports.*		
Soda, ash	1	230
" caustic	3	55
Sodium, sulphate	12	63
Potash, carbonate	26	272
" caustic	3	298
Potassium, sulphate	4	258
" nitrate	30	262
" chloride	3	833
" iodide, &c.	4	187
" bromide, &c.	0	54
" cyanide	0	183
Bleaching powder	1	180
Barium salts, various	10	70
Alum, &c.	1	134
Tartar emetic, &c.	33	58
Sulphuric acid	56	129
Tartaric acid	12	107
Oxalic acid	0	96
Tannic acid	6	98
Salicylic acid, &c.	7	66
Quinine and its preparations	5	410
Alkaloids (santonin, cocain, &c.)	282	290
Carbolic acid	60	112

Principal Articles	Imports, 1,000*l.*	Exports, 1,000*l.*
(*b*) *Exports exceeding Imports* (continued).		
Aniline oil and salts	56	598
Aniline dyes	186	3,982
Alizarine	2	808
Indigo	213	635
Paints, &c.	6	106
Red lead	9	128
White lead	7	288
Zinc white, &c.	68	327
Litharge	4	78
Vermillion	2	56
Ultramarine	2	105
Bronze- and chrome-colours	4	183
Gold preparations	3	128
Lithopon	0	89
Lead pencils, crayons, &c.	17	251
Printing ink	1	93
Mineral waters	116	409
Soap	16	271
Perfumery	77	512
Lacs and lac varnishes	82	141
Dextrin	5	125
Gelatin	8	98
Glue	83	167
Explosives (dynamite, guncotton, and nitro-lignin)	4	322
Gunpowder	2	123
Fuses, cartridges, and percussion caps	10	282
Total, principal articles	4,393	15,475
Other articles	1,142	2,675
Total	5,535	18,150

For comparison with these figures Mr. Evershed constructed the tables given on pp. 220 and 221.

These tables are fairly comparable with those given for Germany, and on contrasting them it will be seen that our exports of what the Germans officially call 'chemicals,' which indicates a somewhat arbitrarily determined group, amount to 13,554,000*l.* (the united totals of the last two sets of figures), as against German exports of 18,150,000*l.*

UNITED KINGDOM, IMPORTS, 1901.

Chemicals, Dyestuffs, and Tanning Substances.

Articles	Imports, 1,000*l*	Re exports, 1,000*l* *	Net imports, 1,000*l*.
Soda compounds:			
Soda ash . . .	11	1	10
„ bicarbonate . .	6	0	6
„ caustic . . .	4	3	1
„ crystals . . .	17	0	17
„ sulphate (salt cake)	0	2	(-2)
„ other sorts . .	46	1	45
Bleaching powder . .	83	0	83
Other bleaching materials .	5	0	5
Borax	154	16	138
Saltpetre	207	23	184
Brimstone	99	15	84
Bark for tanning . .	173	70	103
Cutch, Gambier	392	98	294
Galls	129	85	44
Myrobalans . . .	146	6	140
Sumac	106	19	87
Valonia	324	10	314
Logwood	163	5	158
Other Dyewoods . .	62	11	51
Extracts for tanning and dyeing	522	50	472
Cochineal	8	10	(2)
Indigo	789	462	327
Aniline dyes . . .	539	7	532
Alizarine	202	1	201
Indigotin		See unenumerated	
Other coal tar dyes . .	36	0	36
Undescribed dye-stuffs and tanning materials . .	213	30	183
Carbide of calcium . .	8	0	8
Glycerin		See unenumerated	
Unenumerated (including glycerin)	1,685	339	1,346
Total	6,129	1,264	4,865

* Since the imports destined for re exportation are not always exported within the same year, the third column is apt to be misleading for small values, and occasionally records a minus quantity.

UNITED KINGDOM, EXPORTS, 1901.

Chemicals and Chemical and Medicinal Preparations (of British and Irish Manufacture).

Articles	Values, 1,000*l*.
Soda compounds :—	
Soda ash	282
" bicarbonate	102
" caustic	552
" crystals	32
" sulphate	44
" other sorts	113
Bleaching powder	341
Other bleaching materials	2
Saltpetre, British prepared	27
Aluminous sulphates	36
Sulphate of copper	846
" ammonia	1,607
Other chemical manures	790
Coal-tar dyes	210
Other dyes	130
Carbide of calcium	0
Glycerin	See below
Quinine and its salts } Other medicines }	1,340
Unenumerated (including glycerin)	2,501
Total	8,956

UNITED KINGDOM, EXPORTS, 1901.

Principal British Manufactures classed as Chemicals in German but not in British Tables.

Articles	Values, 1,000*l*.
Ammunition :—	
Dynamite and other high explosives	443
Cordite and other smokeless propellants	240
Gunpowder	
Other explosives (about)	325
Painters' colours and materials	2,008
Glue, size, and gelatin	133
Soap	1,000
Perfumery	182
Aerated waters	145
Direct coal-tar products	?
Total	4,598

These totals, as Mr. Evershed points out, are roughly in the same ratio as the populations of the two countries. An objection might be taken to this comparison on the ground that one year's trade only has been considered; but 1901 was in no sense an exceptional year, and the choice of any other normal year would have yielded results not strikingly dissimilar.

The following figures, which have been extracted from Dr. Rose's report on Chemical Instruction and Chemical Industries in Germany, will give some idea of the advance which has been made in that country in the past few years. In 1890 the excess of export of salts was valued at 701,820*l.*; by 1898 it had reached 1,215,250*l.* The manufacture of potash from potassium chloride dates from 1861: the figures beneath will show how the manufacture has grown since its early days:--

Quantity of Potash produced.

	Tons
1872	1,250
1874	7,250
1878	10,000
1891	25,000

Excess of import (−) or export (+) of Potash.

1866–70	− 5,262
1871–5	− 3,600
1876–80	+ 1,346
1881–5	+ 6,253
1886–90	+ 9,584

In the first half of the last century the German chemical industries grew at a slower rate than those of England, the United States, and France, but of late years Germany has more than recovered lost

ground. In 1898 the total annual production of 'chemicals' in the German Empire amounted, it is said, to as much as 47,391,132*l*. But if Germany has advanced rapidly the English industry has not declined, as one might too readily assume after considering German progress. This is sufficiently indicated by the figures for our export of 'chemicals' as classified in English official returns, although, as we have seen, these do not include all that might be regarded as chemicals :—

Export of Chemicals from the United Kingdom.

1880-1884.	Five-yearly average	7,639,000*l*.
1897–1901.	" " "	8,829,000*l*.
1902.		9,587,000*l*.

The one branch of the trade in chemicals which has aroused more interest than any other is that of aniline dyes; this, therefore, we shall now investigate in some detail. And dyes, we may notice, do not constitute the whole product of the colour industries; there are paints as well as dyes, and our business in paints, at any rate, is not languishing. Our average annual exports of 'painters' colours and materials' for the period 1880–84 amounted to 1,256,000*l*.; for the period 1897–1901 it stood at 1,836,000*l*.; and in 1902 it had advanced upon this by more than 130,000*l*. and reached the figure of 1,968,000*l*. In Germany, Mr. Evershed ventures the opinion, the industry is smaller and less progressive. Passing on to dyes, we may begin by giving the figures for our exports from the time when they were first separately specified :—

Year	Dyes from Coal-tar. Exports.	Imports (including Indigo)	Other Dyes. Exports.
	£	£	£
1882	342,000	416,000	425,000
1883	308,000	387,000	423,000
1884	265,000	555,000	424,000
1885	295,000	487,000	202,000
1886	235,000	510,000	248,000
1887	208,000	548,000	291,000
1888	186,000	569,000	288,000
1889	173,000	609,000	319,000
1890	192,000	594,000	338,000
1891	226,000	586,000	298,000
1892	189,000	542,000	255,000
1893	205,000	504,000	247,000
1894	201,000	599,000	214,000
1895	213,000	710,000	261,000
1896	270,000	741,000	228,000
1897	306,000	695,000	224,000
1898	284,000	739,000	201,000
1899	188,000	709,000	177,000
1900	210,000	720,000	127,000
1901	210,000	777,000	130,000
1902	204,000	—	134,000

These figures are misleading as they stand, if they be taken to represent the quantity of export, since the prices of aniline dyes are now about one-third or one-quarter of their amount some twenty years ago. Even in the last decade the prices of these commodities have fallen about 40 per cent. Hence the decline which the tables above seemed to mark so unmistakably is not, in respect of the tonnage of the trade, a decline at all: nevertheless, a contraction in the value of a trade which is greater than the fall in general prices means that the trade in question is making slighter claims upon labour and capital than formerly, even if the quantity dealt with become no less. And, observe, the figures quoted above afford no indication of the increase or diminution in the value of the home trade. The consumption of aniline dyes has expanded greatly in the last twenty years;

no doubt this has been met chiefly by enlarged production abroad, but English works have certainly acquired some share of the new trade. Relatively, notwithstanding, we have been rapidly falling behind. We must observe, however, when contemplating the rate at which our sales abroad have declined relatively, that our exports of coal-tar dyes never reached half a million in value, and that our imports have only just passed three-quarters of a million. Compare with these values our 62,000,000*l*. of exported cotton manufactures in 1900, nearly 40,000,000*l*. of coal and fuel exports in the same year, and 32,000,000*l*. of exported iron and steel, exclusive of machinery. When dealing with trades in isolation, and considering percentages of decline or advance, it is easy to forget their relative importance in the commerce and industry of the country taken as a whole.

The development of the manufacture of coal-tar dyes in Germany casts into the shade the progress made in any other country.

Exports from Germany of Aniline and other Tar Dyes.

—	Quantities	Values
	100 000 kilos	million £
1889	69·7	1·92
1890	72·8	1·89
1891	86·8	2·21
1892	107·3	2·63
1893	115·6	2·66
1894	128 7	2·66
1895	157·9	3·16
1896	162·3	3·25
1897	176·4	3·35
1898	197·1	3·60
1899	227·0	3·75

In the early 'eighties' artificial indigo was synthesised in Germany, and as a result the importation

of natural indigo into Germany, which amounted to 1,036 tons in 1886, has totally ceased, and Germany is exporting its artificial indigo. The effect of the invention may be seen also in the British importations of indigo, which fell from an average of nearly 90,000 cwts. in the 'eighties' to an average of 64,000 cwts. in the period 1896–1900. We might expect to find India suffering severely in consequence, and the blow which fell on her indigo trade has undoubtedly been serious; but it is stated in a report issued by the Indian Government on the Behar indigo industry that the land now devoted to indigo might be made to yield almost an equal profit when turned to the production of sugar and other crops.

For years the German industry in coal-tar dyes was dependent upon imported raw materials, such as tar oils, naphthalene, anthracene, soda, ammonia, and iron. Hence Professor Von Baeyer spoke as follows to the Academy of Sciences at Munich in 1878:—'Germany, which in comparison with England and France possesses such great disadvantages in reference to natural resources, has succeeded by means of her intellectual activity in wresting from both countries a source of national wealth. Germany has no longer to pay any tribute to foreign nations, but is now receiving such tribute from them, and the primary source from which this wealth originates has its home, not in Germany, but in England. It is one of the most singular phenomena in the domain of industrial chemistry that the chief industrial nation and the most practical people in the world has been beaten in the endeavour to turn to profit-

able account the coal tar which it possesses. We must not, however, rest upon our oars, for we may be sure that England, which at present looks on quietly while we purchase her tar and convert it into colours, selling them to foreign nations at high prices, will unhesitatingly cut off the source of supply as soon as all technical difficulties have been surmounted by the exertions of German manufacturers.'[1] The use of such expressions as 'wresting a source of national wealth,' and 'paying tribute to foreign nations,' and the suggestion that England if awake might cut off Germany's source of supply, tend to obscure the benefits conferred by trade and excite nations to pursue policies at variance with their real interests. To speak in analogy, why should a colour manufacturer refuse to buy pictures because he found it more satisfactory to himself, and more in accordance with his capacities, to make paints than to produce pictures? And what would he gain from refusing to sell artists their paints? This we may fairly say, while fully admitting that the Germans in adapting their genius by scientific training to the chemical industries have attained to a degree of efficiency which is not in general equalled in this country. There is no doubt that far greater use is made of the highly trained specialist in Germany than here.

The early dependence of the German industry in coal-tar dyes on foreign raw materials, to which Professor Von Baeyer referred, no longer exists in the same degree, as Mr. Green has recently reminded

[1] Quoted by Mr. Levinstein, *Jour. Soc. Chem. Ind.* 1886, p. 305.

us.[1] 'The adaptation of condensing plant to the Westphalian coke ovens has rendered Germany, though still a large buyer from England, no longer dependent on English tar and ammonia; by the development of the ammonia-soda process she no longer requires English alkali; whilst all other raw products of the colour industry can now be purchased in the commercial centres of Germany at least as cheaply as in England, and some even at lower prices.' Moreover, the figures given by Mr. Green as to the English patents recently accorded to certain typical English and German firms suggest that Germany is making splendid progress.[2]

In his presidential address to the Society of Chemical Industry in 1902, Mr. Ivan Levinstein attributed the success of Germany partly to her

[1] *Journal of the Society of Dyers and Colourists*, December 1901.

[2] These figures were as follows:

Comparison of Number of Completed English Patents for Coal-tar Products taken during 1886–1900 *by six largest English and six largest German firms.*

German Firms.

Badische Aniline Works	179
Meister, Lucius & Brüning	231
Farbfabriken Bayer & Co.	306
Berlin Aniline Co.	119
L. Cassella & Co.	75
Farbwerk Mühlheim, Leonhardt & Co.	38
Total of six German Firms	948

English Firms.

Brooke, Simpson & Spiller	7
Clayton Aniline Co.	21
Levinstein	19
Read, Holliday & Co.	28
Claus & Rée	9
W. G. Thompson & Co.	2
Total of six English Firms	86

excellent educational system and partly to her well-designed and well-administered patent laws. Mr. Rose, too, in his report above referred to, laid great emphasis on the part played by education in chemical science in the development of the German chemical industries. In Germany the number of scientists who are turning their attention to the industries is increasing; 4,000 trained chemists were working in the German industries in 1897, and by 1901 there were supposed to be as many as 7,250. Mr. Rose concludes as follows: 'The sums expended by the German States upon chemical instruction have been amply repaid by the creation and rapid growth of most important chemical industries and the addition of large sums to the sum total of national wealth. Germany has been enabled by means of the thorough chemical instruction afforded by her universities and technical high schools, and the sound preliminary scholastic education of her students, to rise within the last fifty years to the front rank in chemical industries, and not only to render herself independent of many imports from foreign countries, but also to deprive the latter of many lucrative branches of chemical manufacture and to substitute her own in their stead. Having attained the highest position in the world in chemical industries, she is not abating her efforts, content with the measure of reward which has fallen to her share. On the contrary, it is universally recognised that the efforts made hitherto must be increased, and more carefully and judiciously applied, if the German chemical industries are to maintain and strengthen their position in the future.'

The United States also has developed its 'chemical' industries in no small degree in the last twenty years; but in the manufacture of dye-stuffs and coal-tar products she lags behind. 'In this branch of industry,' it was said in the report on the chemical manufactures for the Twelfth Census, 'the German manufacturers have so developed their resources, perfected their methods, and consolidated their organisation, that they have been able to hold their markets, and to discourage the adventure of capital elsewhere.' The figures which we shall now quote as to the American 'chemical' industries include figures relating to the manufacture of chemicals proper, and of proprietary and patent preparations of drugs, medicines, and compounds, expressed and other oils, non-mineral paints, explosives, fertilisers, dye-stuffs and extracts, salt, petroleum refining, and many similar industries. The value of the produce in this group increased more than threefold between 1880 and 1900, and the capital, wages, and wage earners increased as follows:—

—	Capital in million $	Wage earners (excluding clerks and salaried officials)	Total wages in million $
1880	114	45,400	17·8
1890	323	76,500	33·9
1900	498	101,500	48·9

The electro-chemical industry has also advanced at a greater rate abroad than in this country. The United States in particular is to-day taking the lead. In 1900, 172,000 tons of copper were refined by electrolytic methods in the United States, and 37,000 tons were dealt with in the same way in the United

Kingdom and Europe. The importance of these figures will be more fully appreciated when it is remembered how large a part copper plays in all electrical plant—over 60 per cent. of the copper supplies of the world are devoted to this purpose—and that until the invention of the electrolytic process the conductivity of copper frequently proved defective. The large output of refined copper in the United States is due in a great measure to the extent of their needs and the abundance of their supplies of raw copper; in 1900, of a total production of raw copper of 486,084 tons as much as 268,787 tons originated in the United States. The economies of reducing the raw copper in the land of its origin, when the means are at hand, are obvious; and for all work requiring the use of electrical power the Niagara Falls endow America with an advantage unequalled in any other country.[1]

[1] On the electro-chemical industry see Mr. J. W. Swan's presidential address to the Society of Chemical Industry in 1901.

CHAPTER VIII

MISCELLANEOUS TRADES

In this chapter we shall glance cursorily at the trade in tinplates, paper, furniture, clocks and watches, leather goods, pottery and glass.

The tinplate industry of the United States dates from the coming into operation of the clause in the McKinley Tariff Act of 1890 which raised the duty on 'Tinplates, terneplates, and tagger's tin,' from 1 cent to $2\frac{2}{10}$ cents on the pound. The new rate represented a duty of about 70 per cent. *ad valorem.* It was severely criticised on the ground that it was foolish to protect an industry which did not exist; but as a result of it production and trade were affected as follows:—

Quantities of Tinplates imported into the United States from 1890–1901.
(From the United States Statistical Abstract.)

Year ending June 30	From United Kingdom	From all other countries	Total
	Million lbs.	Million lbs.	Million lbs.
1890	678·9	1·126	680·1
1891	1083·5	2·957	1,036·5
1892	421·8	0·387	422·2
1893	628·09	0·330	628·4
1894	453·88	0·280	454·2
1895	507·07	0·963	508·0
1896	383·88	1·756	385·1
1897	229·2	0·865	230·1
1898	170·87	0·790	171·7
1899	107·8	0·658	108·5
1900	147·3	0·641	148·0
1901	116·8	1·050	117·9

Quantities of Tinplates manufactured in the United States.

Year ending June 30	Tinplates	Terneplates	Amount made from American black plates	Amount made from Foreign black plates	Total
	Million lbs. net	Million lbs net	Million lbs. net	Million lbs net	Million lbs net
1892	4·5	9·1	9·3	4·3	13·6
1893	45·7	54·1	43·6	56·2	99·8
1894	81·6	57·6	86·0	53·2	39·2
1895	120·3	73·5	160·6	33·2	193·8
1896	212·6	94·6	303·0	4·2	307·2
1897	355·3	91·6	446·9	·057	447·0
1898	—	—	—	-	732·3
1899	—	—	—	—	808·4
1900	—	—	—	—	678·0

To correspond with the new duties on tinplates a large duty had also been placed on black plates or plates in the intermediate stage, and the production of black plates in the United States, in consequence, advanced concurrently with that of tinplates.

The Tariff Act of 1894, no doubt as a result of the complaints of the suffering canning industries, reduced the duty on tinplates, &c., from $2\frac{1}{5}$ to $1\frac{1}{5}$ cents per pound, and the duties on black plates as follows:—

Duty on black plates	Act of 1890	Act of 1894
	Cents	Cents
Thinner than No. 20, and not thinner than No. 25, wire gauge	$1\frac{35}{100}$	$\frac{17}{40}$
Thinner than No. 25 . . .	$1\frac{1}{2}$	$1\frac{9}{40}$

By that time, however, the American industry was established, and rates were raised again by the next Tariff Act.

After the passing of the McKinley Act a great

number of workmen from South Wales, which suffered terribly from the sudden closure of the American markets, emigrated to the United States, where their admission was regarded as not in contravention of the immigration laws. Whether their coming was a very considerable assistance to the newly established industry in America or not is a matter of doubt; some firms reported to the commissioner of the 'Engineer,' who investigated the state of affairs in America in 1895, that it was, while others declared that it was not. Now nearly half the industry in America is under the control of the United States Steel Corporation, and the present productive capacity of the works in existence is said to be nearly twice as much as the average output, and in excess of the high output attained in 1899 in the ratio of seven to four. Wages throughout the industry are much higher in the United States than here. As to the quality of the product Mr. A. G. Vansittart, H.M. Consul at Chicago, writes:—'After a strict examination, it appears to have been demonstrated that for household or hard usages the British tin outlasts the American product. It is true the British tin is not quite so bright, but it is far more durable; has a more substantial body; is more evenly rolled; does not aggravate the tin-working machines on account of its smooth body, and does not rust so quickly.' [1]

In view of these facts the accompanying figures as to the export of British tinplates are fully comprehensible:—

[1] See Foreign Office Reports (1897) on the tinplate industry of the United States.

Quantities of Tinned Plates and Black Plates exported from the United Kingdom.

Year	Tinned plates	Black plates for tinning, iron or steel
	Tons	Tons
1886	334,692	—
1887	358,506	—
1888	391,361	—
1889	430,650	—
1890	421,797	—
1891	448,379	—
1892	395,449	—
1893	379,172	—
1894	353,928	—
1895	366,120	34,868
1896	266,963	48,405
1897	271,280	58,648
1898	250,953	58,327
1899	256,373	85,729
1900	272,877	66,278

From these statistics it will be seen that British exports, as a whole, have not suffered so much as the figures relating to our trade with the United States would at first lead one to suppose. And England still retains much of the American market, in consequence of the terms of the Dingley law by which 99 per cent. of the duty paid on tinplates is refunded on their re-export. This arrangement was made to meet the demands of the industries engaged in the canning of meat and fruits. Our output of tinplate, it must be remembered, is not measured by the above declining figures as to foreign trade. The home market has expanded. As many as 358 mills were working here in the period 1898–1901 and 397 in 1902, whereas the number running in 1896 had been 318 only; and Sir John Jenkins declares that in 1902 the output of the Welsh tinplate industry was the largest in any one year of its history.

Until recently England and France effected far the largest sales of paper abroad. Between 1858 and 1862 the United Kingdom exported on an average 455,000*l*. of paper (other than hangings) annually, and in the years 1878–82 the annual export had increased to over 1,000,000*l*. For the latter period our imports of paper for writing and printing averaged only 424,000*l*. France, meanwhile, had attained to average annual exports of paper manufactures which were valued at 1,419,000*l*. in the period 1861–65 and 2,020,000*l*. in the period 1881–85.

The large substitution of wood and grass for rags in the manufacture of paper, which has taken place in recent years, has left England without home supplies of raw material. Now our paper mills are fed by wood pulp, which is imported chiefly from Canada and Scandinavia. Hence the British industry is reduced to maintaining itself against Americans, Germans, and Swedes, in the face of the undoubted differential advantages, in respect of supplies of raw material, which are enjoyed by them. That it has succeeded in maintaining itself speaks well for the efficiency displayed in the manufacture here. The American industry has of late years made gigantic strides; Americans are said to be running their mills now at a speed which in this country is regarded as barely possible. However, according to the report of Mr. Dyson for the Mosely Commission, a pronounced reaction is observable at the present time against very high speeds. According to the same authority the mechanical equipment of the American mills is superior to that of the

majority of mills in this country, but 'in many cases the quality and finish of the manufactured article are inferior to English make.' America possesses the advantages of almost unlimited supplies of raw material and cheap power, and at the present time the expansion of the industry is to be seen in the construction of paper mills in thickly wooded districts where the supply of water is adequate.

American competition is keenest in the cheapest sorts of paper; in fine writing paper and the best qualities of printing and art papers England holds her own.

The cheapness of American products in England is due, in no slight degree, to the striking specialisation of mills in the United States. This large-scale specialised production has caused anxiety in Germany as well as in the United Kingdom, and the German paper-makers have, in consequence, agitated for increased import duties. In Germany in the paper-making industry, small orders are taken customarily by all firms for almost all varieties of weights, sizes, and shades, whereas in America each mill confines itself, as a rule, to some one quality.[1]

For every man employed, Germany yielded recently about 14·5 tons of paper per year, but the United States 38 tons. This indicates as much the qualities of paper produced as the higher degree of specialisation and larger use made of machinery in the United States.[2]

The figures in the table that follows show how our trade stands to-day. The value of our exports has

[1] *World's Paper Trade Review*, June 6, 1902.

[2] *Paper Trade Review*, May 23, 1902.

not declined in the last twenty years; nor have our exports per head of the population declined if allowance be made for the degree in which general prices have fallen. The percentage of increase in population

Exports and Imports of Paper for the following Countries (000's *omitted*).

Country	1897	1898	1899	1900	1901
England					
Exports (paper or pasteboard):	£	£	£	£	£
Writing or printing, and envelopes	1,017'	922'	883'	1,124'	1,095'
Hangings	175'	192'	196'	170'	195'
Pasteboard, millboard, cardboard, and cards, including playing cards	52'	55'	59'	61'	75'
Unenumerated, and articles of paper, except bags	281'	262'	285'	293'	276'
Imports:					
Unprinted	2,536'	2,499'	2,618'	3,113'	2,966'
Printed or coated	312'	301'	346'	410'	422'
Strawboard, millboard, and wood-pulp board	632'	730'	759'	889'	954'
United States					
Exports:					
Paper hangings	—	—	27'	30'	26'
Printing paper	—	—	497'	525'	727'
Writing paper and envelopes	—	—	88'	96'	111'
All others	—	—	584'	648'	686'
Imports:					
Lithographic labels and prints	—	—	166'	189'	197'
Parchment papers	—	—	12'	15'	7'
All others	—	—	486'	587'	680'
Total of paper and manufactures of	650'	591'	664'	791'	884'
Germany					
Exports:					
Paper	2,970'	2,964'	2,959'	—	—
France					
Exports:					
Paper and manufactures of	2,188'	1,994'	2,256'	—	—

in the last twenty years is about the same as the percentage of decrease in general prices. A greatly augmented consumption of paper per head has, however, been experienced, and this has been met largely by increased purchases from abroad. The market upon which our hold has not relaxed is that for the best qualities of paper.

We shall conclude this chapter by contrasting some figures relating to a few of the more important trades which we have not been able to examine in any detail, namely the trades in leather goods (including boots and shoes), watches and clocks, furniture, and pottery.

The splendid pioneer work of America in bringing watches and clocks within the range of all classes needs here no special mention: the causes of American success were originality of conception, simplicity of design, high specialisation, standardisation, and the introduction of automatic machines. In respect of furniture, if we are to rely on the report of Mr. Ham for the Mosely Commission, American manufactures are not more advanced than those of this country. If quality is to be considered, England is ahead. And, according to one American works manager, were the tariff removed—and, presumably, the existing relative levels of prices maintained—American markets would be secured by English makers in many classes of goods. The Americans excel in cheap repetition work, but the skill of the average workman is not high. This is not surprising seeing that the trade is largely adopted by immigrants from Austria, Hungary, Bohemia, and other Southern European States. The same high specialisation

which is noticeable in other American industries is to be found also in tanning and the manufacture of boots and shoes. 'In the States' tannery or leather-dressing establishments you scarcely find a good all-round man, with the exception of the foreman or superintendent,' wrote Mr. Lapping for the Mosely Commission, 'and these I found in many cases have come from some part of the United Kingdom. The rule seemed to be, one man one section of work.' Admitting the cheaper production in the United States, the same writer adds :—'I maintain that this cheaper production is brought about by the causes I have before mentioned—the natural conditions; the immense amount of labour-saving machinery used; the sectionising of the work; and the organisation in the workshops. In America the machines run at a higher speed than ours, and the people work enormously harder.'

Exports of Furniture from Different Countries (000's *omitted*).

—	United Kingdom	United States	Germany	France	Italy	Austria Hungary
	£	£	£	£	£	£
1891	592'	616'	215'	699'	182'	419'
1895	517'	685'	280'	467'	395'	448'
1900	687'	878'*	370'	560'	495'	624'

* A few new classes inserted

The average annual exports of clocks and watches from the United Kingdom in the period 1885–9 were 175,000*l*., while those of Switzerland in the same period reached 3,346,000*l*. The average annual imports of clocks into the United Kingdom were 422,000*l*., while those of watches were 673,000*l*. in the same years. On the whole, the clocks and

watches exported from the United States are of a cheap kind. The comparatively low value of their exports, therefore, means in quantities a considerable amount.

Clocks and Watches.

Imports and Exports for certain Countries (000's *omitted*).

—	1895	1896	1897	1898	1899	1900	1901
UNITED KINGDOM							
Exports:	£	£	£	£	£	£	£
Clocks and watches .	70'	76'	81'	80'	79'	84'	104'
Imports:							
Watches and parts of	828'	987'	1,241'	1,326'	1,580'	1,363'	1,548'
Clocks and parts of .	475'	561'	537'	542'	572'	540'	526'
UNITED STATES							
Exports:							
Clocks and parts of .	176'	194'	202'	199'	217'	248'	270'
Watches and parts of	74'	111'	167'	161'	171'	164'	217'
Imports:							
Clocks	64'	109'	94'	58'	57'	72'	75'
Watches	211'	229'	233'	144'	221'	293'	350'
SWITZERLAND							
Exports:							
Watches, clocks, and parts of . . .	3,490'	3,891'	4,040'	4,260'	4,433'	—	—

Average Annual Trade in Earthen and China Ware.

United Kingdom (000's *omitted*).

—	Exports		Imports	
	1885–9	1895–9	1885–9	1895–9
Earthen and china ware, including manufactures of clay	£ 2,218'	£ 2,159'	£ 565'	£ 844'

Within the same space of time the United States raised its imports from 1,183,000*l.* to 1,834,000*l.*

Trade in Leather and Leather Wares in 1,000*l. and Five-yearly Averages.*

—	Exports 1885-9	Exports 1895-9	Imports 1885-9	Imports 1895-9
United Kingdom				
Leather (unwrought)	1,422'	1,400'	5,901'	7,982'
Leather (wrought), boots and shoes .	1,903'	1,576'	370'	515'
Saddlery	451'	476'	—	—
Gloves	—	—	1,592'	1,680'
Other sorts (including gloves in exports and saddlery in imports) . . .	340'	400'	244'	456'
United States			1886-9	1895-8
Leather and leather manufactures .	2,050'	4,290'	2,410'	2,700'
German Empire				
Leather, dressed and dyed . . .	2,070'	1895-8 3,092'	—	—
Leather wares, except* gloves . .	5,311'	1895-8 3,291'	—	—
France				
Leather wares	5,313'	3,078'	—	—

* Average for 1886-9.

As to glass and glass ware, the statistics are as follows :—

—	Exports 1885-9	Exports 1895-9	Imports 1885-9	Imports 1895-9
United Kingdom	1,042'	871'	1,648'	2,943'

Our exports have declined, but those of Germany and Belgium have advanced.

Average Annual Exports of Glass and Glass Ware.

	1885-9	1895-9
Germany	1,810'	2,149'
Belgium	1,949'	2,990'

Meanwhile the United States diminished its importations from an average of 1,475,000*l.* over the first term of years to 1,168,000*l.* over the second. On turning to French trade in earthen and glass ware combined, we find an average annual export of 1,540,000*l.* in the years 1885–9, and 2,272,000*l.* in the years 1895–9.

CHAPTER IX

COMMERCIAL METHODS

Selling is a trade in itself. A country might prove highly efficient in manufacture and yet either fail to attract customers on account of bad marketing, or be driven to export through foreign houses. It is therefore desirable to consider comparatively British efficiency in the matter of marketing, since our object in this work is to explain England's position in the world's trade as well as to measure our productive capacities against those of other nations. Commercial and industrial functions must be sharply distinguished; and it is especially necessary to isolate the former for examination in these days, in which the specialisation of 'dealing'—that is, of commercial functions—has become so prominent.

An interesting memorandum on British trade methods, which contained the opinions of our diplomatic and consular officers abroad as expressed in their reports since 1896, was presented to the Houses of Parliament in 1898. In that memorandum special emphasis was laid upon the following causes, among others, as having tended to place British trade at a disadvantage: the disinclination of British traders to supply a cheaper class of goods, to take small orders at first, to study customers' wishes, to adopt

the metric system in calculations of quantity and cost, and to grant credit facilities; the scarcity of British travellers in comparison with those of other nationalities, and their ignorance of the languages prevailing in the countries which they visited. The question of packing to suit the convenience of customers was also touched upon in the memorandum (it was asserted that British methods of packing were, on the whole, inferior to German and American methods); and in addition mention was made of high freights on British lines of steamers, and the frequency with which strikes at home unsettled our foreign trade. The importance of those who are engaged in our export trade making some acquaintance with the business methods of other countries was urged, and it was asserted that the practice of sending young Germans all over the world to learn their business had greatly assisted Germany in pushing her trade.

Let us consider some of these points in detail, so far as they may be regarded as commercial in character. Firstly, there is the disinclination of British houses to supply cheaper qualities of goods. Certain markets are lost to us in consequence—much of the Russian market, for instance, where British goods are unsuitable 'owing to their being too expensive for the market, which is open for cheaper and more showy, if inferior goods.' This passage explains perhaps why Mr. Foster Fraser found no English consul at Vladivostock. Obviously it must be left to British manufacturers to decide whether it would pay to start what might be in effect new manufactures, and produce, against the competition of Germany and

America, the light, cheap, and showy goods which serve their purpose for a time. The retort made by some British manufacturers that they had no desire to establish reputations as the makers of the sort of goods which were winning some of the poorer markets is unanswerable, and it is in addition a welcome sign of some healthy pride still being felt here in the quality of our products.

Agricultural machinery is frequently given in these consular reports as an example of a line of goods in the exportation of which Americans and Germans, particularly the former, are leaving us behind. To this we have already referred in the chapter on machinery. It would be remarkable indeed if England, with its own peculiar agricultural system, could build as cheaply as America the kind of implements which are in use all over America, and are demanded in large quantities for similar work in other parts of the world. It is well for us to be informed that cheap goods are selling where English goods are not selling; but it must be left to English houses to decide upon their next steps. To build machinery to last like the tombs of the Pharaohs is as foolish as to build as if to-morrow we died. In constructing all sorts of appliances the producer should bear in mind that the future will see advance and invention as the past has done. Sometimes the Englishman, with his solid taste, does not adequately realise that things may be too good for their purpose: yet one would preach only with the greatest caution the doctrine of making, instead of the best, things that will 'just do'; things that will 'just do' generally will 'just not do.'

As regards the assertion that British houses are not content with small orders, there is probably much truth in what our consuls have said. The small order leads up to the big order, and business that is once refused, because in some particular year it may have been inconvenient, cannot be easily resumed again. Yet, on the other hand—for there are generally two sides to all these questions—it may be that in many cases the small order is not worth having, and it may not lead to trade in appreciably larger quantities, and, as a rule, it is not worth having if the goods are to be produced in accordance with special instructions. Many of our big works are not adapted to turning out small quantities of goods of special design, and it might not pay to render them suitable for such a kind of business. Large British firms will not meet willingly, promptly, and cheaply the special needs of small customers; but are there no small firms, who, though glad to do so, have not succeeded in making their readiness known? and—we put forward the suggestion with diffidence—might not a higher degree of adaptability in our great industries in small matters of this kind react on their capacity to maintain their efficiency at the highest level attainable in each period? There are two ideals before the producer: the one to reach the lowest cost of production by the large-scale organisation of existing methods; the other to keep a business always half-grown, so to speak, and therefore ready to assume change at any point. In the former case is not the industry in danger of becoming lifeless, mechanical, stereotyped? In the latter, may not too great a sacrifice of cheap production in the present be made for

the future? There we must leave the matter, but not without recording our impression that adaptability—sensitiveness to variations in the environment and rapid and nicely adjusted reactions to meet them completely—adaptability to different quantities and qualities of output, to changes in methods and in the conditions of supply and markets, capacity to undertake orders which must be executed speedily or not at all, will prove an increasingly important element in industrial efficiency. England for nearly the first three-quarters of the nineteenth century held a position of remarkable security; but now a sharpened home competition is supplemented by keen and effective foreign rivalry, the numbers of new commodities have awakened capacities to feel new needs, and industries, unless they be cut off from the inspiration of living in a progressive world, must ultimately prove ready to react at all points on the fluctuations of demand and the conditions of transport and production at home and elsewhere.

The British producer, we are told, will not study the needs of his customers so assiduously as the German producer. English travellers will spend time fruitlessly trying to convince customers that they are wrong in requiring the special kinds of goods which may really be essential if the customer's needs are to be satisfactorily met. But there is something to be said for the English traveller and his supposed folly. The cost of production might be raised quite disproportionately if only a small alteration were effected in the character of the goods being offered; and there are other considerations to be weighed.

In many little ways it is made difficult for

foreigners to buy from us. For instance, take the following, extracted from the report of our consul at Bilbao in 1901. In an English price list of provisions and groceries printed in Spanish, all the values were expressed in English money and all the weights were given in pounds and ounces. Moreover, these conditions of sale were stated :—' Messrs. —— will not hold themselves responsible for fines or claims imposed by foreign Governments on account of imperfect descriptions or errors of any kind. Purchasers are begged to examine all merchandise before shipment, after which no claim will be recognised, as every article is guaranteed good and sound in shipment.' Any Bilbao buyer would have been compelled to be represented by an agent at the port of shipment, and he would have been required, in addition, to pay any penalty, which might be severe, on errors of description made by the sellers. No prudent man would undertake such a risk.

' Suiting the customers' convenience is a point that the Consuls say cannot be urged too much as a means of pushing foreign trade. Some of the practical ways of doing so which are in vogue among other nations may be mentioned here. The foreigner does everything in his power to save his customer trouble.' A fixed price is quoted for goods delivered duty free at the quay of a port or in any particular town abroad, which includes freight, shipping charges, packing, and any other expenses up to that point. The price is stated in catalogues in the languages and currencies of other countries. A purchaser abroad is thereby enabled to see at a glance what the articles will cost him when delivered.

'Our usual practice is merely to give in English the cost of the article at the home manufactory, and in English money, an almost exactly opposite system, which leaves the buyer to discover for himself, if he can, a work which he will often not take the trouble to do, what the cost of that article will be when it reaches him, after paying freight, shipping, packing, and other charges, &c., and what the cost in *l. s. d.* is equivalent to in his own currency. These all involve nice calculations which some would-be purchaser may not be capable of performing, and which in any case require considerable labour and inquiry. The chief cause of success in foreign competition is the greater attention paid abroad to the art of exactly suiting the foreign customer's pocket, taste, and convenience—an art in which foreign nations pre-eminently excel.' However, British houses are sometimes requested not to quote delivery prices, since they might not know the cheapest way of passing goods through the customs—the goods might not be classified by officials in the most favourable manner. But it is not wise to give in any catalogues English weights and measures; one might as well state the dates for delivery in Ides and Kalends. Upon this point we shall quote only the Consul at Naples. 'It does seem absurd that the first commercial nation in the world should measure their horses by hands and their dogs by inches, their cloth by ells and their calico by yards; that such impossible numbers should come into their square measure as 30¼ and 4,840; and in their measure of solidity as 1,728. And the weights are worse still. It can never

be too much impressed upon British trade that all goods for sale on the Continent should be marked in metres and kilogs., and all catalogues sent to the Continent should be in a language "understanded of the people."'

The introduction of a new system of weights and measures into a country is no easy matter. Reform is kept back by the customs of the people—forty years after the metric system had been adopted in France penalties had to be imposed on those employing the discarded standards of measurement—and by the cost of altering all the existing weights and measures, and in addition the machinery which has been constructed to work on other units; but that the obstacles in the way of change are not insuperable is evident from the spread of the decimal system over almost all parts of the Continent.[1] The United States is in the same position in this matter as England, but the United States is not involved in the same amount of trade with the continent of Europe as the United Kingdom. America's best customer and provider, namely the United Kingdom, uses the same system as herself.

As to credit, after the recent experience of certain German houses which had pushed trade too much upon this system, little is to be said, and that little must be said cautiously. Credit rules the modern world; without it our economic organisation would be less complex, commodities would be dearer, and our wants would be less fully satisfied; without it, moreover, unendowed capacity would find itself almost

[1] See Reports from H.M. representatives abroad on the metric system, Parts I. and II., 1900 and 1901.

powerless to push its way into the place of established incompetency; yet in relying upon it we live over the craters of innumerable volcanoes. Credit may be granted too readily. When attempts are being made to extend its influences to less economic states, credit itself is pushed only at the greatest risks, for credit, if forced, almost inevitably defeats its objects by causing irresponsibility and therefore distrust; but efforts to strengthen, develope, and organise the conditions of sound credit cannot meet with any but the best results. Possibly we trust our foreign customers in new markets so far as the dictates of prudence permit us to go; but do we offer them the conditions of being trusted further? Sound credit is based on knowledge, and there can be little credit that is not gambling in markets where the eye of the agent is not continuously present. Catalogues may advertise a British firm, without bringing about the sale of many goods, since credit might be needed for the purchase of goods, and the firm which is not represented in the locality should take few risks. Credit may co-exist with penury, but organisation is needed to direct it in such a way as to render it of appreciable economic value. 'People's Banks' have proved successful on so grand a scale abroad because Schulze and Raiffeisen discovered the secret of eliciting and aggregating small credits. Trading houses engaged in opening up new markets might learn useful lessons from studying the systems which have done so much to vitalise the farming and small industries of Germany and Austria.

A lavish distribution of catalogues is no substitute for resident representatives or even for travellers.

No catalogues can speak with the tongues of gifted commercial travellers. For the want of English agencies, for example, it is alleged that British goods are being excluded from Italian markets. The following figures have recently been put forward :—

Figures published by the Swiss Government as to travellers who entered Switzerland in 1899, so far as they were obtainable.

Travellers for	German houses	in Switzerland	3,828	during 1899.
,,	French ,,	,,	1,176	,,
,,	Italian ,,	,,	350	,,
,,	Austro-Hungarian	,,	183	,,
,,	Belgian ,,	,,	44	,,
,,	British ,,	,,	28	,,
			5,609	

(From Consular Report, Bilbao, 1901.)

Commercial travellers for houses of foreign nationality who entered Spain by Port Bon, Bilbao, or Irun in 1900.

French	128
German	52
Austro-Hungarian	9
Swiss	8
British	8
Italian	8
Belgian	2
	210

These tables might prove very misleading. Germany, France, Italy, and Austria all lie contiguous to Switzerland, for example, and French is the language of parts of Switzerland and German of other parts. Moreover, much English business is done through agencies instead of through travellers, and it is said that the latter as a rule would have no occasion to visit the consulates; and their presence would, therefore, remain unknown. Besides, it must be remembered that some of our exporting is done through foreign houses established in England.

In too many cases our travellers are bad linguists, or even talk no language but their own. 'It is pitiable,' wrote our Consul at Naples, 'to see the British commercial traveller stumbling along with an interpreter, while his German competitor is conversing fluently.' Local British traders, Mr. Ransome tells us in his 'Japan in Transition,' speak less Japanese and associate less with the people than any other foreign residents. Hence some British firms employ German commercial travellers, who, perhaps, represent also German houses. The result is said to be only what one might expect; and floods of catalogues in English, however well illustrated, cannot do the work of travellers who know their business. Such catalogues are said to be taken by their recipients to the agencies of German, French, and other firms for explanations and information as to the complete cost to the buyers of the goods described, and naturally the foreign firms are found to supply articles for the same purpose at as low a price at least.

Certainly the German commercial traveller is a good man of business, and unequalled as a linguist. The commercial enterprise of Germany was displayed recently in a striking fashion in South Africa: no sooner was peace proclaimed than German agents seeking orders for machinery and tools seemed to spring up on all sides. To the excellent selling powers of our foreign rivals we must attribute the facts that leather goods have recently been exported direct to the Cape from this country through German shipping houses, and that orders for goods to be exported to Chili and Argentina have come very largely

through Hamburg or Paris.[1] But of all travellers, Americans, except as linguists, are perhaps the most successful at the present time. The American is a splendid salesman; and, if he is trying to make a market for goods the purposes of which require explanation, he is, as a rule, a technical expert also. Engineering firms in the United States appoint frequently as travellers intelligent and trained artisans: they are supplied with excellent catalogues, and are well supported by their firms. American agents will guarantee and persuade and offer to take risks in the names of their firms until hesitating customers are left with no reasonable option but to buy. This matter we have discussed at some length elsewhere,[2] and there appears to be a case for the manufacturer to examine into. Further, it would be of value to consider how far in each industry the economies are with the specialised trading firm, and how far with manufacturers selling through travellers.

[1] *Leather Trades Review*, February 18, 1903.
[2] See p. 130.

CHAPTER X

RAILWAYS

SINCE the conditions of internal communication are of fundamental importance to a country's economic activities, some account of the railway systems of this country and other leading countries ought to be given in this work. In attempting such an account we have confined our remarks almost entirely to freight traffic in general, omitting any mention of the passenger service and the conveyance of parcels, since we are dealing here with railways chiefly in so far as they subserve the great industries. Much that we have to say unfortunately is unavoidably negative in character, and relates partially to the difficulty of drawing comparisons and the errors into which the investigator who tries to hasten to a positive conclusion is liable to fall. A far more exhaustive and direct investigation than we are able to make would be needful to settle at all exactly the real costs of railway services in different countries, the efficiencies displayed in the provision of these services, and the charges all round that are made for them. We have aimed also at explaining in this chapter some of the divergences that exist between the railway systems that prevail in different places.

In the table annexed the mileage of lines in different places is stated :—

At the end of 1897.[1]

Total mileage	455,010
United States	184,392
Germany	29,898
Russia (with Finland and Siberia)	28,320
France	25,689
Great Britain and Ireland[2]	21,404
British India	21,016
Austro-Hungary	20,921
Canada	16,694
Italy	9,720
Argentine Republic	9,428
Belgium	2,850

Railway mileage alone does not offer a satisfactory indication of the degree in which railway enterprise has extended in different countries, for a variety of reasons, even if the mileage be given in lengths of single line, which is not the case in the table above. In interpreting statistics of railway mileage the magnitude of countries has to be taken into account, not merely to show railway services in relation to the area served—and the thinner the population *cæteris paribus* the greater is the length of rail required to further the same amount of exchanging—but also because in countries of equal economic stand-

[1] In these returns no allowance is made for the number of lines on the track.

[2] The growth of our railway system has been as follows :—

—	1850	1860	1870	1880	1890	1900
Total mileage in existence	6,621	10,433	15,537	17,933	20,073	21,855
Mileage added in previous decade	—	3,812	5,104	2,396	2,140	1,782

ing the ratio of the railway service to the country overlaid determines in some degree the nature of the system. The longer the typical journey the more will there be a tendency to avoid physical obstacles, rather than to overcome them by engineering operations, and the greater will be the proportion of single lines. In short, the whole system in such a case will tend to be laid down on a cheaper plan. The population must be taken into account also, as we have already suggested, for roughly it is the population per square mile of which the railway system is a function. 'Roughly,' we say, because it is questionable how far in this respect countries may be compared as a whole. Countries may be similar as regards some districts and totally different as regards others: to contrast, for example, the United Kingdom as a whole with Belgium could only lead to erroneous conclusions, though the railway mileage of England, taken apart from the mountains of Scotland and Wales, and the bogs and almost unpeopled tracts of Ireland, when compared with that of Belgium, would afford some general idea of the relative state of railway development. However, again we must qualify any conclusion at which we might arrive, for not only have physical features and the proportion of population to area to be brought into our estimates, but also the use made of the railroad system when it is laid down. Hence it will be requisite in the course of this chapter to institute certain comparisons in which statistics will be of little or no avail. Having stated these points for observance we may now offer tables of railway mileage calculated in proportion to area and population :—

Railway Miles per 100 *square miles about the end of* 1897.

Belgium	32·2
Saxony	29·5
England and Wales	26·3
Great Britain	24·5
Baden	19·8
Alsace and Lorraine	19·3
Great Britain and Ireland	17·5
Germany	14·3
Netherlands (including Luxemburg)	14·1
Switzerland	14·1
Prussia	13·2
France	12·4
United States	6·3

Railway Mileage in Relation to Population.

—	Year for which population is taken	Railway mileage at end of 1897 per 100,000 of population	Population per square mile
Canada	1900	303·5	1·8
United States	1900	241·6	26
Argentine Republic	1899	209·5	3·6
France	1898	66·3	188·5
Germany	1901	52·6	270
Great Britain and Ireland	1901	51 7	341·6
Austro-Hungary	1899	46·5	Austria 206·3; Hungary 140·4
England and Wales	1901	45·2	About 580
Belgium	1899	42·2	583·6
Italy	1901	30	293·3
Russia, Finland, Siberia	1897	27·6	Russia 49·9; Finland 17·0; Siberia 1·2
British India	1901	9·1	239·4

To form a satisfactory idea of the facilities in respect of railway transportation offered to the inhabitants of each country, apart from passenger service, we require to know in addition to railway mileage, population, and area, the use which is made of the permanent way. Thus we must make inquiries as to :—

(1) The work done reckoned in ton miles. This

should vary roughly as the population, for though the amount of tonnage moved for each person is less when the density of population is low, each ton is moved on the average a greater distance. We may notice here that statistics of train-mileage are of little value for international comparisons now that railway rolling-stock and the length of trains have accommodated themselves in so high a degree to the peculiar needs of each country, though for comparison of the state of affairs in any one country from year to year within a limited period they are still of service. There is an unwillingness on the part of almost all English railway companies to provide ton-mileage figures on the alleged ground of the heavy cost of collecting them.[1]

(2) The number of the trucks and their size. Clearly, however, the country with the largest trucks is not necessarily the best served. To this question we shall return later.

(3) The average frequency of the load of each truck. This should vary, *cæteris paribus*, as the density of population. One nimble ten-ton truck might do the work of a fifty-ton truck.

We have quoted below statistics as to goods carried and miles travelled by goods trains in 1901.

—	Goods carried. English tons	Miles travelled by goods trains
	'000 omitted	'000 omitted
United States . .	959,764'	507,842'
United Kingdom .	415,952'	178,062'
England and Wales .	351,116'	146,521'
Germany . . .	320,840'	172,294'
France . . .	120,880'	119,747'
Belgium . . .	49,288'	87,748'

[1] The North-Eastern Railway Company prepares them and the London and North-Western Company is reported to keep them for private use.

However, statistics of tonnage carried and miles travelled by goods trains may mislead seriously. For the goods conveyed may have been taken long or short journeys on the average, and the goods trains, of which the total journeys are stated, may have been large or small. Again, in the first column of this table, unfortunately, no allowance is made for duplicates, that is, traffic passed from one line to another. The figures are arrived at by adding together the tonnages dealt with by each company. Hence the mere amalgamation of companies in any one country would reduce its figures of tonnage carried, the quantity of work actually done remaining as before. To make these figures comparable it would be necessary to suppose that the ratio of duplicates to the total work done was roughly the same in the countries considered or that it was in all cases inappreciable; but neither assumption are we in a position to make. The quantity of duplicates is certainly not an insignificant amount in some countries. In the United States in the year ending June 30, 1901, the total tonnage dealt with was returned as 1,089,226,440 short tons, but when duplicates were excluded the amount fell to 583,692,427 tons.

These are the approximate figures as to certain kinds of rolling-stock in possession of the railways in 1901:—

—	Goods and mail waggons	Locomotives
United States . .	1,410,000	39,700
United Kingdom .	698,000	21,700
England and Wales .	582,000	18,500
Germany . . .	384,000	15,800

There is, in addition, the rolling-stock owned by

other businesses to be taken into account. In England the number of private waggons is unusually high: it is estimated to be in excess of half a million. Germany, we notice, has more miles of line than the United Kingdom; but a larger proportion of the German lines is single. We possess, however, a great many more trucks. As regards the size of trucks, it is observable that there is a tendency to introduce waggons of greater capacity in Germany as well as in the United States. In 1889 the total number of goods waggons in Prussia was 183,000; in the next ten years it increased 50 per cent., but in the same period the total capacity of the trucks increased 90 per cent. Now 15-ton four-wheeled waggons are common, the old waggons have been strengthened to carry 10 to 12½ tons, and 30-ton waggons are used for certain purposes. To the advance which has been made by England in accommodating the carrying capacity of goods waggons to English needs, which are not necessarily identical with those of Germany or the United States, nor even identical in different parts of this country, we shall refer later. As to the use made of rolling-stock only the scantiest figures appear to be obtainable; but official information has been furnished to show that in Prussia more work is now being obtained from each truck on an average than heretofore, partly, no doubt, as a result of improved management, and partly because the business to be done has so increased and accommodated itself to the conditions of transport as to render possible this economy in use, which involves a large saving on capital account. In 1892 each truck in Prussia was

loaded on an average once in three and a half days, but in 1899 once in three days; in 1889 for every 1,000 miles per axle run loaded 535 miles were run unloaded, but in 1899 the second figure fell to 438 miles. And with bigger waggons and heavier trains have come more powerful engines.[1]

Under the heading of the use made of rolling-stock we might contrast English and American methods of using locomotives; in America an engine runs day and night except when it is stopped for cleaning or repair; in England, as a rule, the proportion of engines 'dead' to those 'in steam' is very high. In the matter of the use to be made of all kinds of appliances, whether locomotives or machines in factories, there is much to be said for the system, whenever it is at all possible, even though it involve a somewhat higher capital charge, of each man exercising entire control over a certain portion of the appliances, which he may regard as in a sense his own. The appliances are thereby kept cleaner and are worked more carefully and intelligently so that the best use is made of them; for they are regarded with a sort of sentimental attachment and their peculiarities are known.

The railway systems of different countries have been laid down at widely divergent costs per mile. The following figures of the total cost of construction per mile have been put forward:—

1896-7	£
Great Britain and Ireland 1896 (entire system)	48,898
Holland 1896 (Dutch railways)	39,768
Belgian States	28,044
Switzerland 1899 (entire system)	27,697

On the above see the Consular Report on Prussian Railways of 1902.

1896–7	£
France, 1896 (great companies)	25,282
Germany (entire system)	20,275
Italy, 1894 (nine lines)	18,448
Belgium, 1896 (Great Central)	16,024
Russia, 1896 (entire system)	15,454
United States, June 1897	12,221

These figures, however, must not be taken as accurate expressions of the actual cost of construction. In being reckoned from the accounts provided by railways they are open to a multitude of errors, and are in some cases barely comparable with one another. For example, in America the watering of stock has taken place in numerous instances to such an extent that many authorities regard the calculation of cost of construction from the nominal capital, including the debt, as wholly worthless; moreover, a calculation of this character makes no allowance for the amount of earnings spent in construction and possibly the amount of debt spent on working expenses. Again, different systems of allocating expenses to revenue and capital respectively prevail. In England, as a rule, extensions and alterations (but not renewals, which may be regarded as necessitated by wear and tear) are charged to capital as real additions to the property of the companies, but in the United States all payments are usually furnished from revenue, except such as are incurred in laying down entirely new tracks. For example, the present alterations on the Pennsylvanian line, which involve such expensive works as the substitution of viaducts for level crossings, are being met wholly out of revenue; in England, in so far as they consisted in alterations

of the line of a fundamental character, they would be charged to capital.

But even if the actual costs of construction were discovered, great differences would still be found between the costs of construction in different countries, which would be due in a large measure to the following causes:—

(1) Differences in the cost of land and law expenses.

(2) The time when most of the line was laid. England pioneered and laid lines when metal was dear and engineering methods were less perfect than they are to-day.

(3) The nature of the permanent way, the proportions of line with double track and more than two tracks, and the number and magnificence of the stations. German cars, for example, are constructed to render platforms unnecessary. And where the density of population is low the number of stations to a given length of line will tend to be small.

(4) The physical features of the country traversed and the way in which obstacles are avoided or surmounted.

We might now glance at some of the features of German, American, and English permanent ways which have caused differences in the cost of laying them. The reasons for these diverse features we shall examine in more detail later. On the Continent and in the United States level crossings are common, even in the environs of large cities, and cuttings and viaducts are infrequent. There is a tendency, however, to adopt the English system as far as possible wherever the concentration of traffic

both on the lines and across them has accentuated the inconveniences of more primitive arrangements. Again, there is the quality of the road itself. The English roads, an observer from the United States reported in 1898, are superior to the American in solidity of structure.[1] But it must not be supposed that roads in the United States are dangerously flimsy. On the contrary, some of their permanent ways appear to be splendidly solid: a trial section of standard London and North-Western line was laid by London and North-Western men and maintained by them for the Pennsylvanian Company, but it is said to have given way under traffic—which beyond question is exceptionally heavy—that was borne by the native line uninjured. However, Colonel Yorke has pointed out that the latest type of London and North-Western line was probably not tried, and he rightly holds that a test under the peculiar conditions of the Pennsylvanian road is far from conclusive.

American engineers used to lay down rails of 80 lb. to 85 lb., but now the more important lines which have to provide for heavy traffic have adopted the 100-lb. rail. In Germany a yard of rail weighs 83 lb. The English rail for main lines varies from 85 to 103 lb. the yard, and the English railway chair weighs from 40 to 54 lb. In England the rails are held down by chairs which are clamped to the sleepers; the chairs to carry heavy rails have a base of 105 square inches. Neither in Prussia nor in the United States are chairs employed: the rails in use are those known as 'T' rails or Vignoles, and they are secured to the sleepers by means of ordinary spikes. The

[1] *Railroad Gazette*, February 11, 1898.

number of sleepers to a given length of line is greater in America than here; probably with heavier traffic we should be compelled to increase the number of sleepers. In America fourteen to sixteen sleepers or ties are used for 30 ft. of heavy rail, and eighteen sleepers for the same length of light rail, whereas in England only twelve sleepers at most are required for 30 ft. of line. In Prussia the lengths of rail are 39 ft. 4 in., and the number of sleepers to a length is sixteen, that is, a fraction over twelve to the 30 ft.

The Americans claim that their roads are easier to lay, cheaper to maintain, and smoother to run over than the English roads, and that they are no less durable. However, the superiority of their system is under dispute and Colonel Yorke has recently criticised it. He points out that though fewer sleepers are employed in England, they are longer—9 ft. by 10 in. by 5 in. in England, as compared with 8 ft. by 8 in. by 7 in. in America, and 8ft. 10 in. by 6¼ in. by 10 in. in Prussia—and consequently for a given length of line the bearing area afforded by sleepers is greater here than in the United States or Prussia. For a 30-ft. length of rail the bearing area here is 90 square ft., whereas in America it is 74·6 square ft. with fourteen ties, and 85·3 square ft. with sixteen ties.[1] Again, the English chair with its wide base affords a valuable support against lateral pressure, which is of particular importance on curves where the lateral pressure is at times considerable. At such places in America, because of the weak resistance offered by the lines to lateral pressure, it is usual to prop the rails with small

[1] See note on next page.

brackets called rail-braces. It is also usual to place bearing-plates or tie-plates between the rails and the ties, with the object of increasing the bearing of the rail on the tie and affording support to the spikes; but according to Colonel Yorke these tie-plates shear off the heads of the spikes. The weakest point in American construction is the use of so primitive an instrument for holding down the rail as the spike; in Prussia both screws and spikes are generally used, the former on the inside to prevent the rail from turning over, and the latter outside where they are quite efficacious for resisting pressure outwards. Naturally spikes when used alone work loose, and have to be frequently driven home again; and each time they are forced back their hold is rendered less tenacious than it was before. This defect is serious in America even, with its hard ties of oak or chestnut; but in England, where the sleepers are hewn from soft Baltic timber, it would be fatal. Hard wood is, in fact, essential to

NOTE.—Mr. Pratt, in his work on American railways, gives somewhat different figures.

Name of Road	Ties			Bearing surface per 30 ft	Percentage of bearing surface above Pennsylvania Standard	Number of ties per mile
	Number to 30 ft. rail	Width	Length	sq. ft.		
Pennsylvania Standard	14	7″	8′ 6″	69·42	0·0	2,464
Pennsylvania Old Standard	16	7″	8′ 6″	79·84	14·8	2,816
Other U.S. roads	18	7″	8′ 6″	89·25	28·6	3,168
L. & N.W., England	10	10″	9′ 0″	74·97	7·7	1,760
L. & S.W., England	11	10″	9′ 0″	82·50	18·8	1,936

the American practice, and it is therefore problematical whether the price of hard wood in England would not render the American system as costly here as our own.[1] In one small respect the Americans, however, have improved the permanent way, namely, in preventing the joints of the rails from lying exactly opposite to each other. The joint is the weakest part of the rail for resisting both vertical and lateral pressure, and it is obviously unwise to allow the weak spots to correspond. In respect of ballasting, said Colonel Yorke, the English and American lines are about equally good.[2]

In Prussia the sleepers are made, as a rule, of oak. Hollow metal ones have been tried there as elsewhere, but it was found that they tended to crack just outside the rail on sharp curves; and, since the friction between the sleeper and the ballast is not so great when the sleeper is made of iron as when it is made of wood, metal sleepers are disposed to creep. Iron longitudinal sleepers have also been given a trial in Germany, but the lines tended to spread and difficulties were met with in draining the permanent way. Naturally the spreading of the lines is far less likely to occur when each is fastened to the same sleeper which is placed at right angles to the direction of the rails. One objection to the wooden sleeper is the difficulty and cost of protecting it against the weather so as to render it moderately durable. Recently experiments have been made in Germany to determine (*a*) the preservative qualities

[1] Illustrations of the English and the American method of holding down the rail will be found in E. A. Pratt's book on American railways.

[2] On all the above see Colonel Yorke's report to the Board of Trade in 1908.

of creosote as compared with chloride of zinc, and (*b*) the exact strength of creosote required to keep a sleeper from chemical decay just so long as it can endure normally against the destructive forces of mechanical action. Herein the German thoroughness and the scientific bent of the German mind are again exemplified.[1]

We cannot undertake to decide whether German and Belgian traders are, on the whole, in a position of advantage when compared with English traders in respect of railway services; but we must remind the reader that numerous considerations are to be weighed before it can be concluded from the lowness of many continental rates that greater efficiency in the performance of carrying goods overland is being displayed abroad than in the United Kingdom. (1) The capital charge per unit of traffic might be higher in one country than another on account of circumstances over which the railways had no control. (2) The ton-mile cost falls with the length of the journey. (3) Station to station rates are easily confounded with rates including collection and delivery; the latter are more usual in this country than elsewhere. (4) The promptness expected in delivery must be taken into account; with this point we shall deal in some detail later. (5) No general conclusion can be based on the comparison of a few rates, since the principles underlying the determination of rates are such that for similar work the charges might be higher in one place than in another, even with the work being done under the same system. (6) Preferential rates might almost be regarded as the rule rather than the

[1] As to details, see Embassy Report on Prussian Railways of 1902.

exception in Germany, and (7) special rates are charged for goods despatched in large quantities.

In Prussia, while about 17 per cent. of the ton-mileage is despatched under special rates, as much as 63 per cent. is charged preferential rates. Preferential rates are officially described as 'applicable to agricultural and industrial products, and intended to assist and facilitate import and export, and increase the traffic of the country'; and inasmuch as almost all the German broad-gauge railways are under State (but not Imperial) control, their charges can be arranged in this way to encourage or discourage certain trades as Ministers may think best. The preferential rates may in many cases be regarded as operating (*a*) as bounties to certain districts to enable them to compete with foreign and other products in remote German markets, (*b*) as export bounties—for example we may take the preferential railway rates accorded in 1890, 1895, and 1897, on goods bound for the Levant, East Africa, and Eastern Asia respectively, and the special reductions made in 1893 and 1897 on the carriage of iron and steel goods, (*c*) to increase the traffic on such lines as are working in competition with foreign ones, (*d*) to support certain industries—for instance, iron and steel, ship-building, the Silesian textile industries, agriculture, (*e*) to support manufacture in general, *e.g.* the fuel rates of 1897 and 1900, and the 'raw material' tariff, and (*f*) to alleviate the distress due to bad harvests and floods in certain districts.[1]

A great many of the German preferential rates,

[1] Upon this question see Mr. Gastrell's report on preferential tariffs in 1897, and the Embassy Report on Prussian Railways of 1902.

however, have not acted as positive bounties on exports and trade at a distance, but as correctives of the discouragement of all long-distance trade which was brought about by the Reform Tariff. In general, the idea of the Reform Tariff, which was introduced in Germany about a quarter of a century ago, and is we believe still operative, at least theoretically, was that an equal rate per ton-mile should be charged, and, in addition, fixed amounts per ton for terminal expenses; but when it became evident that the terminal charges would destroy the short-distance traffic, these were lowered at the expense of the ton-mile rates, with the natural result that the long-distance business was overburdened. The opportunity thereby presented for imposing a further check on the importation of manufactured articles was too good to be lost. The situation, therefore, was relieved by a system of rebates, which were never accorded to such foreign commodities as entered into competition with German produce, and no doubt the preferential rates in some cases left the exporter in the position which he would have occupied had the rates been governed wholly by the interests of the railways.[1]

There appears to be no doubt that, on the whole, railway rates are lower in the United States than in England. But average rates and costs, which are calculated by dividing the work done into lump takings or expenses, may prove highly misleading, in view of the fact that the average lengths of haul and train capacity vary so widely, that the quantity of work done at special rates is variable also, and that

[1] An account of the German Reform Tariff will be found in Acworth's *Railways and the Traders*.

different customs prevail as to the proportion of collecting and delivering undertaken by the companies. For example, the French have developed their long-distance traffic very little and the Americans a great deal, while in America the scope for the development of such traffic is unique in its immensity. Again the English railways engage in collecting and delivering far more than the railways of France, Germany, or the United States of America. However, the considerations stated above notwithstanding, when the available evidence is duly weighed the conclusion that, on the whole, railway services are offered at a cheaper rate in the United States than in England would seem to be inevitable. The reader must, nevertheless, be warned against supposing that the contrast is in reality so great as certain picked figures would make it appear; and it must be borne in mind also that the American ton is 2,000 lbs. only, whereas the English ton is 2,240 lbs., and that figures for American transporting are calculated on the basis of the short ton unless it is otherwise stated. Probably Mr. Acworth's opinion on the question as a whole, advanced in 1891, still remains the most balanced judgment that has been passed,[1] and no doubt it corresponds fairly with the present facts, although the Americans have effected great improvements in the last dozen years. Mr. Acworth wrote:—'On the whole, I believe that a fair statement of the case as regards rates, leaving questions of accommodation out of consideration, would be somewhat as

[1] Some recent average rates and costs will be found in Mr. Paish's book on the British railway position; but Mr. Paish's figures are liable to be misapprehended for the reasons stated above.

follows: The average American rate, being charged mainly on wholesale consignments of cheap goods for immense distances, is immeasurably lower than ours. On the trunk lines to the West the whole of the rates are kept down by the operation of the 'long and short haul' clause, and the public feeling which gave rise to it, to a level which, though by no means so low as that of the through rates, is yet much lower than that prevailing in this country. But when it comes to the traffic on branch lines, in what may be called local distributive service, or to the traffic in perishables, which can hardly be brought into comparison with wheat and tinned meats, or to parts of the country where the influence of the wholesale through traffic is but little felt, the rates are at least up to the English standard; while for traffic of the more valuable descriptions they are without question very considerably higher.'

Recently railway rates have fallen considerably in the United States, and to-day the average expenses per ton mile and the average earnings per ton per mile are much less in the United States than in England. The fall in freights in the United States is due in a large measure to the enormous development of long-distance traffic; it is due also in some measure perhaps (partially as a consequence of the increased quantity of long-distance traffic) to an enlargement of the train-load. On the New York Central the train-load rose from 258 English tons in 1896–7 to 365 tons in 1900–1; on the Lake Shore Railway it advanced from 119 tons in 1872 to 224 in 1880, 238 in 1890, and 404 in 1900; but on the London and North-Western the increase was insignifi-

cant, from 59·4 in 1872 to 65·6 in 1880, and 68·6 in 1900, after a fall to 65·5 in 1890.[1] To-day the difference between the train-load in the United States and England is gigantic. On the Pennsylvanian line in 1900 the train-load was 431 tons; on the London and North-Western it was 69 tons, and the highest in England no doubt was the 92·5 on the North-Eastern for minerals only. The following are the train-loads on other American lines in short tons (*i.e.* 2,000 lbs.):—

Atchison	242
Chesapeake and Ohio (revenue load)	511
" (with company's freight)	538
Norfolk & Western	435
Northern Pacific	328
Great Northern (U.S.A.)	381

And these figures convey a very inadequate idea of the size of the train which is frequently run in the United States, inasmuch as many trains have to run light, especially when most of the traffic is in one direction. On certain lines trains of a gross weight of over 2,000 to 3,000 tons are to be seen being dragged by mammoth engines of over 100 tons in weight. In England a large increase in the density of traffic has been met in the slightest degree only by an enlarged train-load, and hence rates have not tended to move inversely with the density of traffic as in America, where the train-load has been immensely enlarged. For instance, on the London and North-Western an addition of 29·8 per cent. to the ton mileage in the period 1880–1900

[1] India also has recently increased its train-load. In the June half of 1872 it stood at 113·75, but in 1880, 1890, and 1900 it had become 148, 202, and 196 tons respectively.

(the amounts being 1,194,078,000 in 1880 and 1,549,556,000 in 1900) was met by an addition of only 4·6 per cent. to the train-load, which advanced apparently from 65·6 to 68·6 tons.[1]

A larger train-load may mean that fewer half-filled trains are run, and in that case almost the whole of the increase would be pure gain; or it may mean that the railway management is adding to the size of the typical train and to the strength of the locomotive. Other things being equal, the train-load should rise for the former reason as the traffic becomes thicker, since the larger the amount of the traffic the greater is the chance of its proving capable of division into equal-sized groups for transmission. Filling the trains which run either way, and discovering the rates which will fill the trains in such a manner as to yield a maximum net profit, is one of the problems of railway management. When we glance at the figures for England relating to train-loads, it certainly appears as if most of the difference could be accounted for in the way just described, and, therefore, as if little had been done, the efforts of certain companies in that direction notwithstanding, in the way of raising the weight of the typical train.

The economies of the large train-load are so obvious as scarcely to need demonstration. Saving is effected in engine-drivers, stokers, and guards; in signalling and organising the traffic on the road in general, since there are fewer units to organise; in a greater proportion of paying weight to dead weight being secured in the case of each train; in the wear

[1] See, as to these figures and those quoted above, Mr. Paish's book on the British railway position.

and tear of the permanent way, since the number of stoppages, from which arise the most serious damage to the road, is reduced; in capital invested in rolling-stock, since the larger the engines the less is the cost per unit of power, within limits, and the larger the waggons the less is the expense of carrying capacity per unit.

The typical train could be enlarged by adding to the size of the trucks or the length of the train; but obviously there are limits to the degree in which the length of the train could be increased without the trucks being enlarged. Recently some interesting experiments upon this question were made by Mr. Gaines.[1] Five trains were made up as follows[2]:—

—	Size of Truck	No of Trucks	Revenue Load
	Tons		Tons
1	20	66	1,336
2	25	55	1,354
3	30	47	1,364
4	40	37	1,527
5	50	36	1,824

Trips were run by these trains over the same division of line, with the result that trains 3, 4, and 5 consumed about the same quantity of coal, whereas trains 1 and 2 consumed more. The fifty-ton truck on a fairly short train, therefore, proved the most economical under the conditions which ruled during these tests; and the trucks of half and less than half that size were far the most expensive. It is obvious that, even if all trucks are made of the same width, the carrying capacity of a

[1] Mr. Gaines's paper, read to the New York Railway Club, was reproduced in the *Chicago Railway Age* of May 31, 1901.

[2] Quoted from Paish, p. 121.

given length of train is greater the larger the trucks of which it is made up.

Another point which has been raised is whether the long car on bogies is best, or a shorter car on four wheels. In the United States the eight-wheeled truck is supplanting the shorter car; after the car has passed a certain length mounting on bogies of course becomes necessary to facilitate the taking of curves and for other reasons. Moreover, it is said that the four-wheeled truck with its rigid wheel base is more wearing to the road and more taxing to the locomotive than the bogie truck. It is urged further that the bogie truck offers a larger proportion of paying load to total weight; but recently the London and North-Western and Great Western Companies have constructed twenty-ton trucks of the old-fashioned pattern with a tare of only eight tons, which is about the same percentage of dead weight as exists in the American fifty-ton steel cars mounted on bogies. In India, where larger cars are coming into use, the tendency is to keep to four wheels and build on that design up to the maximum of carrying capacity, which with the present regulation diameter of wheels is about seventeen tons. An expert engineer, in a letter to the 'Statist' dated October 2, 1901, contended that the way of reform of least resistance led up to the large seventeen-ton truck.

The magnitude of the truck, the train, and the locomotive in America is scarcely realised by the public in this country. The standard type of car in the United States has a carrying capacity which varies from 30 to 40 tons of 2,000 lbs. each; fifty-ton

cars are not unusual, and even cars with a carrying capacity of 100 tons and a total weight when fully loaded of 130 American tons are to be seen. The average load on the Pittsburg Bessemer and Lake Erie Railroad from the opening of traffic in 1899 up to August 24 of that year amounted to 1,644 short tons, or a total weight behind the tender of 2,137 short tons. In the United States undoubtedly the large-scale system pays. For example, in the annual report in 1899 of the New York Central and Hudson River Railway we read: 'The introduction of twenty-eight new Mogul locomotives, each capable of hauling eighty loaded thirty-ton grain cars (making a gross weight of 3,600 tons for the train and its load, or 2,400 tons [1] of paying load), has resulted in a saving of 505,114 train-miles, or $3\frac{1}{2}$ per cent. decrease, although the volume of freight traffic was $8\frac{1}{2}$ per cent. greater. Twenty additional locomotives of the same type were ordered towards the close of the year.'

That questionings as to the efficiency of the British service have been aroused is not surprising. Mr. Samuel Fay, sometime superintendent of the London and South-Western Railway Company and now manager of the Great Central, who has recently been investigating railroad practice in the United States of America, before sailing for home said to an interviewer: 'Where the American roads are far superior to ours is in the economical management of the freight traffic. This is the reason why they can show greater net earnings while charging lower freight rates and paying higher wages than our roads. One of the first things the English roads will have

[1] Short tons of 2,000 lb. each.

to do will be to get heavier and more powerful engines for freight traffic.'[1] Again, Mr. G. S. Gibb, the general manager of the North-Eastern Railway, has spoken out with a directness which admits of no misunderstanding. 'I have no doubt,' he says in the Introduction to Mr. Paish's book, 'that more can be done in the direction of increasing train loads and wagon loads in England, and, further, that more will be done as soon as better statistical information is ready for practical use by the management.' Again, to quote the opinion of one who did not see with English eyes, the director of a German steel plant, who was interviewed for the 'Berliner Tageblatt' on his return from the United States, said that in his opinion the American railways surpassed any others with which he was acquainted in respect of cheapness and efficiency. Mr. Paish adds that an American railroad president, who had closely studied English railways, had severely criticised them, in conversation with him, and had expressed his conviction that much greater economy and efficiency could be reasonably expected.[2] And something has already been effected. For certain services larger trucks have been introduced, and the adaptation of the truck to the purpose for which it is required—that is, in short, a division of labour among rolling stock—which is so noticeable in America, is becoming increasingly manifest here.

There is a limit to the extension of truck capacity in Great Britain. Our whole system is specialised to suit a particular type of rolling stock. Much wider waggons are impossible, because they would leave an

[1] *Colliery Guardian*, November 1, 1901. [2] P. 6.

insufficiency of space for safety between trains, for here the distance between parallel tracks is 6 feet, whereas it is 7 feet in the United States. The huge engines, standing from 14½ feet to 16 feet in height, which are used in the United States, could seldom pass under our bridges or penetrate our tunnels, since over-bridges in England rise as a rule 14 feet 3 inches above the level of the rails, whereas in America they reach 18 feet. Further the wide American rolling stock would find it impossible to enter our stations or pass over many of our bridges. Difficulties were of course encountered by enlargements of the rolling-stock in the United States, but they presented there a much less formidable obstruction. In England, again, the general introduction of the larger truck and longer train would prove very costly, since turn-tables, weigh-bridges, goods-yards with their sharp turnings and sidings—the number of which is legion on the British system, which reaches with its ramifications to the very doors of innumerable factories and warehouses—are accommodated to the small truck and short train. Moreover, the possession of so much of the freight rolling-stock and of innumerable sidings, yards, and turntables by private persons stands in the way of fundamental changes. Lastly, we must observe that larger or wider trucks would mean much heavier trains, and that numbers of our bridges, in addition to proving too narrow for the wider truck, would be incapable of bearing the additional weight. But many of these arguments, it might be said, applied to reform in the United States. They did not, however, apply in the same degree. The mass of the American lines is much cheaper per mile, and

an enormous proportion of the track is single; the permanent way winds more to avoid the necessity of embankments, cuttings, viaducts, and tunnels; and the bridges are less costly structures. Hence the adaptation of the railroad to much larger trains would necessitate a far greater destruction of unexhausted capital in England than in the United States. A change which might be economical there would be foolish here. Besides, it is open to question whether in many cases it is not cheaper to run many light trains by a direct route over a costly viaduct than a few heavier trains over an even costlier viaduct, or by a roundabout route which avoids the necessity of a viaduct. The argument in this paragraph, it must be noted, has no bearing on the extension of truck capacity within certain limits, and there seems to be no doubt that ultimately many of our turn-tables and sharp corners will have to be removed. Much of the British system, which was designed for an earlier age and simpler business, will in course of time—but not suddenly—be swept away to make room for arrangements by which labour is saved, and the rapid handling of traffic is facilitated. British goods-yards are certainly not equal to such American yards as might fairly be compared with them in respect of design and labour-saving arrangements, but probably the high efficiency of the average British railway man keeps the cost of handling reasonably low notwithstanding. Much that was said above as to our ship-building yards might be said with equal truth of our railway goods-yards.

There are two questions to consider: the first, Would it pay to adopt a much larger train if we were

starting afresh? the second, Would it pay to introduce much larger trains by making alterations in our existing system? Mr. C. J. Owen, the general manager of the London and South-Western Railway, has answered the first question in the affirmative, but not the second.[1] We are 'hampered by our inheritance'; but it does not therefore follow that it would have been wiser to have prepared in the past for the use of a larger train in the future, or to have worked the goods traffic with higher capacity waggons in the past had that been possible. And we are not so sure that the first question can be answered unhesitatingly.

While somewhat larger trains might prove economical in England, it seems unlikely that so big a train as that which is becoming typical in America would suit English requirements. The unit of load on a railway system will vary with the frequency of the service, and the latter will vary as the distances to be traversed. Every person knows that if he purchase some commodity from a shop near at hand he will buy in smaller quantities than if he purchase from a shop several miles away. If the distance to be traversed in marketing is great, every effort will be made to save journeys by buying in stores. This statement may be generalised; it applies throughout business, and the explanation is simple. To buy in small quantities is a convenience, and it is frequently worth the cost of making a few extra journeys to secure it. But if the journeys are long the cost in many cases becomes more than the convenience is worth. Hence an American producer will find it

[1] International Railway Congress, 1900.

economical to have an amount of capital locked up in stores which have had to be carried long distances, when an English producer—who is, as a rule, nearer the home market in which he buys—will find it most satisfactory to pay a little extra on transport with the object of avoiding the locking up of capital and the cost of storage. Hence large-scale production offers greater advantages over production on a small scale in America than in England. For other reasons, also, the typical business tends to be larger in the United States than in England, and this reacts on transportation and necessitates a larger normal load. Thus on the side of the traders the conditions in America have brought about a system of infrequent purchases in large quantities.

Hence there has sprung up in the United States a railway system which in many instances does not permit of frequent deliveries. The United States possesses over 200,000 miles of railway, whereas the United Kingdom contains an amount which is only between one-ninth and one-tenth as much; but the proportion of line which is double or more is enormously greater in England than in the United States.[1] Very frequent services cannot be attained over a single line, nor can rapid services. More-

[1] Complete figures are not procurable, but the following have been furnished us by Mr. Dewsnup, who kindly read this chapter and made suggestions on his return from investigating railway matters in the United States. The total mileage of the United Kingdom reckoned in single track was about 36,500 at the end of 1902. These figures do not cover sidings. There are, therefore, some 14,500 lines of additional single track in the United Kingdom on the roads alone. In the United States, on 125,000 miles of line examined, out of the 204,000 miles in existence, some 15,500 miles of additional track were discovered, excluding freight-yard tracks, sidings, and spurs.

over, the less dense the traffic the less will it pay to make the line run direct at the cost of expensive engineering operations. The directness of the route is, roughly, a function of the population per square mile, and upon this depends also the singleness or doubleness of the line. Numerous illustrations could be found: as a single instance we may take the following. In one of some recent articles in the 'Times' on American railways we read that a 'passenger who travels on the main line of the Pennsylvania may observe in the valley of the Juniata, in some places side by side, (1) the original single line bought forty years back by the company from the State of Pennsylvania, winding almost along the bed of the stream; (2) a first-class double line, substituted for it, but still with a good many curves and kinks; (3) the main line of the present day, as straight and as solid, built one might say in as monumental a fashion, as though it had been constructed by Brunel himself.' No more convincing single instance could be quoted to indicate that lines in sparsely peopled places tend to be laid light, single if long and crooked if the land is broken, and to grow solid and strong, double and straight. Roughly, one might say that the capital expenditure per mile on the permanent way varies, other things being equal, directly as the population and inversely as the area served.

In a thinly populated country slow and heavy trains must be looked for. Moreover, less promptness in delivery must be expected, since considerable economies would result from waiting until a full load could be secured for a large train without any important conveniences being sacrificed. The lack

of promptness would in turn react on the unit of purchase, since buyers would not be able to depend upon receiving immediately over the railroad small or large quantities as they needed them. In England railways do retailers' work by carrying small quantities and delivering express. As Lord Stalbridge, the chairman of the London and North-Western Railway, put it [1]: 'In this country a merchant in Manchester, Liverpool, Leeds, York, or any other of the big towns, feels that he must receive in the morning the invoice of goods awaiting delivery that left London only the night before, whereas in France and the rest of the Continent they have never less than three days allowed for delivery, and at some distances five, six, or seven days.' 'If goods could be kept that length of time in this country,' he added, 'so that full train-loads could be made up and dispatched at convenient times, the goods traffic could be conducted more cheaply, but it would be impossible for railway companies to reduce rates if they had to deliver with the expedition prevailing at the present time.' In England, moreover, ordering in small quantities is said to be on the increase.

We have implied that the size of the truck may be regarded roughly as determined by the typical unit of load; as to this a few words must now be said.

When economic organisation has advanced to a hand-to-mouth existence many goods must be dispatched as soon as they are consigned, and frequently the batches which naturally form themselves are not sufficient to make up a big train.

[1] At a dinner at the Hotel Cecil on May 11, 1901.

And it is economical for the size of the truck to accommodate itself, as far as possible, to the size of the typical consignment, since thereby loaded trucks may be delivered at the doors of the buyers over private sidings instead of portions being unloaded from large trucks, which would require loading on to smaller trucks or carts for delivery. In short, to save handling, it is convenient that as much as possible should be delivered in truck loads. Then the most sensible arrangement, it would appear, might be to use trucks of different sizes. But there are limits to the possibility of extending variety far in rolling stock. There are mechanical objections to trains made up of differently constructed waggons of widely divergent capacities; and the whole railway system, at an enormous cost possibly, would have to be adapted to the largest truck in use over the whole system. Let there be but a few very long trucks mounted on bogies and overhanging the wheels more than is customary now in this country, then the space between the sets of lines throughout the system would have to be widened, tunnels, bridges, and viaducts would have to be enlarged, station platforms set back, sidings lengthened, and turntables more than doubled in size in so far as they were used by the new long trucks. It might be worth while to sink the additional capital which such alterations would involve were the whole of the rolling-stock to be constructed on the larger scale; but it certainly would not pay, even were we starting to lay down our system afresh, to make the permanent works on such a magnificent scale as was strictly necessary only for a small quantity of

the rolling-stock. This becomes obvious when we bear in mind that all the extra cost involved in permanent works beyond what was requisite for the small truck would have to be charged to the large truck; and it is quite certain that the economies arising from the use of the large truck would be immeasurably less than the amount of this extra cost. But of course our trucks could be given somewhat higher capacities without this extra cost being incurred. And a certain elasticity in waggon capacity is desirable. The above is true only in general. There is no reason why, in one stage of a country's development, different gauges, as well as trucks differing in shape and capacity, might not be economical. Were it possible to build an economical and efficient locomotive several thousand tons in weight and proportionately powerful, it might conceivably pay to run trans-continental American traffic over a broad gauge in trucks as big as Atlantic liners made up into huge trains. Certainly where a service is highly specialised, as that between Pittsburg and Lake Erie, developments can be carried out in some degree, though not entirely, without regard to the nature of surrounding systems.

It must not be supposed that British Railway Companies have refused to try the larger truck or that the larger truck would never prove economical under British conditions. On the contrary experiments with high capacity waggons have been conducted over most of our lines with satisfactory results in some cases, though in others the cost of the service was raised. In one instance it was found that some thirty-ton waggons which had been intro-

duced for a particular branch of work could be run loaded in one direction only and could make no more than thirteen journeys a month each on the average, even after care had been taken to get the best possible out of the service by organisation. In that instance the large trucks were discontinued; but for some of their business certain of the leading companies to-day regularly employ waggons with carrying capacities of 30, 40, and, in the case of the Caledonian ore trucks, even of 50 tons. Above we have been speaking not of exceptional traffic, but of our system taken as a whole.

That America has adopted the automatic coupler universally is no proof that greater care is taken of human life in the United States than in England—which is certainly not the case—for the reform is not the same thing by any means in the two countries. The cost of the alteration per ton handled is obviously much less in the case of large trucks. That the change is highly desirable is unquestionable. The law of the American Congress by which automatic coupling and air brakes on all freight trains engaged in interstate commerce were rendered compulsory came into full force on August 1, 1900. Upon the present working of these systems some interesting criticisms will be found in the report of the Inter-State Commerce Commission for 1902. The coupling mechanism is said to be far from perfect, especially that needful for uncoupling; 'the needs of the future, in respect of couplers, may be described under the heads of strength, simplicity, and finish.' Breakages are said to be too frequent. The report, again, criticises severely 'the present condition of the air brakes on the freight cars of the country, the lack of thorough

training and discipline of the men in charge of trains, and the insufficiency of the forces assigned to inspection and repair.' In some States, particularly in the East, freight cars are still being worked down steep inclines by hand brakes, to reach which the brakesmen must run about on the roofs of the cars. This is a highly dangerous practice, not only on account of the motion of the train, but because of bridges, the number of which is increasing.

In the important matter of signalling the United States has recently made great changes. In many places signalling is effected by an electric circuit which is completed for a section when a train is on the rails but broken when it leaves the rails in that section. The current flows along one rail and back along the other when the two are connected by the presence of a train on the line. This is the fundamental idea; the details of the system may be left to the imagination. When the circuit is complete a signal at the beginning of the section marks 'danger'; when the circuit is broken the signal alters. Usually a train is protected by two adverse signals behind it. The idea is ingenious, and in the opinion of experts it will have a great effect on railway working. But obviously it could not entirely supplant the existing system, and many improvements in automatic signalling will be needful. It is said that 'track circuits' do not work well if they are very big; in America a block section of 700 to 1,300 yards only has been adopted. This is very short; with running at high speeds it might sometimes mean intervals between trains of much

less than a minute. Moreover it would seem that a driver watching for signals every 1,000 yards must be kept constantly in a high state of nervous tension. American lines formerly suffered from an insufficiency of signals; now there is a fear of the drivers being unnecessarily worried by too many, and being prevented from running over certain sections with any confidence at high speeds. No doubt larger track circuits will soon be rendered possible. In another respect the Americans have made an advance—namely, in the working by power (electric or pneumatic) of points and signals, which reduces physical labour to a minimum and causes conspicuous economies.

In England there are peculiar difficulties associated with our climate which will render automatic signalling even less satisfactory than it is in the United States. Fogs here are not infrequent; to meet them the automatic mechanism must be strengthened and complicated, and when complicated it would be more likely to break down; or else an army of trustworthy men would have to be employed, and it would not be possible to obtain at short notice and merely for a short time men who could be relied upon to make no mistakes. Again, as Colonel Yorke points out, snow, frost, and lightning might under certain circumstances cause a signal to stick at 'all right' when it ought to be registering danger. Even under normal conditions automatic signals must be kept under constant supervision and testing. Systems of partially automatic signalling are to be found on certain of the great lines in this country, and the power-working of points and

signals by electricity and compressed air is by no means unknown.

On the whole Colonel Yorke judges that signalling in the United States is far from perfect. It is, he says, in an inchoate condition. Different systems are employed, and in some places lines are fully signalled whereas in others they are hardly signalled at all. The uniformity which reduces the risks of fatal confusion to a minimum is far from being realised in the United States. So far block working applies to only 25,000 of the 200,000 miles of American line; but its sphere is extending, and under many circumstances it is not so necessary as in England, with its higher average density of traffic. And as regards the working of single lines, Colonel Yorke criticises severely; the system used, the so-called 'train-order' system, was long ago abandoned in England as both troublesome and dangerous.

America, again, is showing enterprise in making experiments with electric driving. Electric motors may be seen in the United States hauling loads up to 1,500 tons over heavy gradients in Baltimore on the Belt Line; but at present electricity, we are told, is only economical for frequent services. On one part of its system the New York, New Haven and Hartford Railway has electrified all its local passenger service, the current being conveyed by a third line between the other two,[1] and the experiment is said to have resulted in quadrupling the number of passengers, reducing the total cost of working, halving the fares, and adding enormously to the frequency

[1] The experiment of electrifying the line has also been tried in Prussia between the Wannsee station in Berlin and Zehlendorf.

of the trains and consequently to the convenience of passengers. That the use of electricity will contribute in a remarkable degree to the effectiveness of local services in the future is unquestionable. In Germany experiments with high speeds are being made by a society for investigating the question of the pace attainable with electric traction. Already a speed of 99½ miles an hour has been reached, but the strain on the road was so great that a more solid line had to be laid down before a greater pace could be attempted. The existence of English initiative in the matter of electric traction is evident from the planning of an electric mono-rail between Manchester and Liverpool and from the electric passenger services of the metropolis.

We cannot leave the question of the transportation of commodities over railroads without referring to the high degree of specialisation on railroad and lake alike which has been introduced for the carriage of ore from the Lake Superior mines to Pittsburg. Plants, mines, railroads, and ships have been combined in one vast undertaking, and now all parts of the business of assembling materials and smelting fit accurately into each other, and are so adjusted as to save all unnecessary labour. One of the most remarkable of American achievements is the cheap carriage of more than 20,000,000 tons of ore annually from the Lake Superior mines to the furnaces, in spite of the enormous distance and the double handling involved in addition to that at the mines and the furnaces. The result is reached by a wonderfully close adaptation of means to ends; by the adoption of every possible labour-saving and

time-saving appliance, the simplification of processes and their adjustment together. Ships have been designed for the Lakes alone—their draught must not exceed 20 feet at most—and to carry ore alone. They are loaded through ten or more hatches at once, and from pockets placed in piers alongside of which the vessels lie, the pockets being placed at distances which are a ratio of those between the vessels' hatches. Boats and piers have been constructed to fit each other—herein is another example of the American method of effecting economies by means of standardisation. The piers vary in length from 570 to 2,336 feet, and they rise from 37 to 73 feet above the water. The pockets discharge their loads through spouts which run from them to the hatches of the vessel. Each pocket will contain about 250 tons of ore; and a vessel, having taken in a first charge of 2,500 to 3,500 tons from ten, twelve, or fourteen pockets at once, will proceed to another set of pockets and receive a further charge of the same amount in the same way, and in a space of time measured by minutes. It is said that one boat of 5,000 tons capacity was loaded in twenty minutes, but the time usually occupied varies from two to four hours. This period, however, is sufficiently short to render it unnecessary for the vessel to blow off steam. Ships have been constructed to carry over 8,000 tons, but the 5,000-ton boat is now preferred.

For unloading, either on to trucks or into storage, machinery is employed which is suited merely for the transhipment of ore, and has involved an outlay that would have rendered its use uneconomical were the quantity of material to be dealt with much less in

bulk than it is. Much ore has to be stored either at the eastern Lake port or at the furnaces, because the Lake route is free from ice for only five months in the year. The rapidity with which the unloading is effected may be gathered from the following: 'During my visit to Conneaut,' said Mr. Sahlin, 'I saw a steamer arriving in the morning with a cargo of 6,700 tons of ore leave the same evening in ballast for the Upper Lakes.'[1] The best known machines for effecting this result are the Brown fast plant and the Hulett automatic unloader, of which a full account, together with illustrations, will be found in the report of the commission to America of the British Iron Trade Association; and recently another system, the Hoover and Mason, has been introduced. The cost of unloading a ton of ore with the Hulett machine is 1*s.* 2*d.*; but as the grab bucket which it shoots down into the vessel (for it acts much like a bird's beak) must not be allowed to come in contact with the frame, because it would act on it like a ram, only 75 per cent. of the cargo can be shifted in this way. In Europe the American automatic unloading plant could not be used at present owing to the build of vessels; in America the structure of the ore-carrying vessel has been adapted to the conditions of automatic unloading.

Carriage on the Great Lakes is remarkably cheap. From the head of Lake Superior to Cleveland, south of Lake Erie, ore can be conveyed at a profit for about 2*s.* 6*d.* a ton, though this price is said to be unusually low:[2] the freights for ore from Bilbao

[1] Report in 1902 for the British Iron Trade Association, p. 420.

[2] P. 7 of Report of the Iron Trade Association's Commission.

to Cardiff are at least *4s. 6d.*, while the distance is only a hundred miles greater.

Such ore as is not dumped at the ports is loaded direct on to steel trucks of a 50-ton carrying capacity, and the average train removes about 1,024 tons at once. The largest weight carried, according to the report of the commission referred to above, amounted to 1,849 tons; the whole train weighed 2,404 tons. Trucks are constructed to unload automatically; at the Lake Superior end of the voyage they discharge their ore automatically into the pockets from which the vessels are filled. Throughout the American industry this perfection in 'handling' (in many cases it has ceased to be handling in the correct sense of the word) and transporting is noticeable. Coke is carried in specially constructed waggons. Coal, which loses in value if it suffer much breakage, is discharged from trucks to ships as gently almost as if it were glass, and yet quite automatically, by the beautiful and powerful mechanism of the Brown coal tipple:[1] at Cardiff also, in South Wales, fine machinery of much the same character may be seen. The great problem of industry, even of social life as a whole, in the vast North American continent has been largely one of transporting, and the various solutions of this problem which have been brought into operation are to-day the admiration of the civilised world.

[1] On all the above see Mr. Sahlin's report above referred to, the *Times* correspondent's letter on American engineering, and the Consular Report of 1902 on the iron ore industry of the United States.

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